“RENAL RESISTIVE INDEX AS A PREDICTOR OF ACUTE HYDRONEPHROSIS IN PATIENTS WITH RENAL COLIC ”

Dissertation submitted in partial fulfilment
of the requirements of

M.Ch DEGREE EXAMINATION
BRANCH 1V – UROLOGY

GOVERNMENT KILPAUK MEDICAL COLLEGE & HOSPITAL
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AUGUST 2015

CERTIFICATE

This is to certify that this dissertation entitled **"Renal Resistive Index As A Predictor of Acute Hydronephrosis In Patients With Renal Colic** submitted by **Dr. P.SENTHILKUMAR** appearing for **M.Ch (Urology)** degree examination in August 2015 is a original bonafide record of work done by him during the academic period of August 2012 to July 2015 under direct supervision and guidance in partial fulfilment of requirement of the Tamil Nadu Dr.M.G.R. Medical University, Chennai, Tamilnadu, India.

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This is to certify that this dissertation entitled **"Renal Resistive Index As A Predictor Of Acute Hydronephrosis In Patients With Renal Colic"** submitted by **Dr.P.SENTHIL KUMAR appearing** for **M.Ch UROLOGY** degree examination in August 2015 is an original bonafide record of work done by him during the academic period of August 2012 to July 2015 under my guidance and supervision in partial fulfillment of requirement of the Tamil Nadu Dr. M.G.R. Medical University, Chennai. I forward this to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India.

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DECLARATION BY THE CANDIDATE

I, **Dr. P.Senthil Kumar ,** solemnly declare that this dissertation titled **"Renal Resistive Index as a Predictor of Acute Hydronephrosis in Patients With Renal Colic"** was done by me in the Department of Urology, Kilpauk Medical College Hospital and Government Royapettah Hospital, Chennai Under the guidance and supervision of **Prof.Dr.K.SARAVAN M.S, M.Ch, (URO)** Professor of Urology, Govt. Royapettah Hospital,

This dissertation is submitted to the Tamil Nadu Dr.M.G.R. Medical University, Chennai-600032 in partial fulfilment of the University requirements for the award of the degree of M.Ch. Urology.

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Place: Chennai
Date: 30-03-15

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TABLE OF CONTENTS

INTRODUCTION

Urolithiasis remains a major health problem worldwide. The burden of urolithiasis in India was very high with 11. 6 %. During the last 25 years. It has been associated with an increase in incidence and prevalence. Renal colic accounts for 30 to 35% of urological emergencies .The incidence is 3 times more common than women [1 – 3]

Patients with Renal Colic are 33 % to 68.3% risk of acute urinary obstruction (partial or complete) which leading to hydro uretero nephrosis.[4-6] Hydro uretero nephrosis can cause progressive deterioration of renal function over time[7].

If the obstruction is caused by stone disease, spontaneous resolution can occur, more or less rapidly. The frequency of recovery depends on the size of the stone. If the obstructed calculus persisted for more than 4 to 5 weeks, renal function may impaired irreversibly [8] .So, we have to diagnose and treat the obstruction as early as possible.

Studies have shown that dilatation may be absent in the early phases of renal colic, when patient were imaged in dehydrated state, and this can lead to misdiagnosis in 30% of cases [9]

First line Investigations commonly done for patients with renal colic are X - ray KUB and ultrasonography. Second line studies are Intravenous urography and Plain CT –KUB with reconstruction

Each of the imaging methods has their own advantages and disadvantages. Their Sensitivity and specificity in diagnosing the cause of obstruction, site and grade of obstruction are very well documented in the literature Most canters donot practice IVU in acute colic, because of its complications[10]

Non enhanced CT had 91 to 100% sensitivity and 91 to 97% Specificity [11.] CT is the investigation of choice for patients with acute colic because it reduces assessment times and helps to reach an answer to patients clinical condition.[12,13]

CT is unsuitable for follow up purposes because of its radiation effects[14,15]. Smaller calculi (<3 mm), radiolucent calculi are easily missed by CT imaging. It is difficult to differentiate stones from phleboliths and vascular calcifications using CT scan.[16]

MRI has 100% sensitivity and 96% specificity in diagnosing urinary tract dilatation. It accurately diagnoses the cause of obstruction in 99 to 92 % of all patients [17,18] MRI is still not

routinely used for diagnosing stone disease, because of its limited availability and cost factor

In 50% of the cases of acute obstruction Ultrasound fails to reveal hydronephrosis .[19]

US has sensitivity of 37% for direct visualisation of ureteral calculi. [20]

So, Doppler US can be used to improve the diagnostic efficacy.

Renal duplex Doppler sonography would allow diagnosis by distinguishing Obstructive dilatation from non obstructive dilatation or acute obstruction from the chronic form[.21,22,23] Previous studies had conflicting results about the efficacy of duplex Doppler USG[24,25].

Our study was done to determine the sensitivity of the renal resistive index in diagnosing obstructive uropathy taking non enhanced helical CT as the gold standard.

AIMS AND OBJECTIVES

1) To determine the diagnostic accuracy of renal arterial resistive index in the diagnosis of obstructive uropathy.

2) To determine the diagnostic accuracy of delta resistive index in the diagnosis of obstructive uropathy.

3) To compare renal RI and delta RI with CT KUB and find out sensitivity, specificity, Positive Predictive value, Negative Predictive Value of the indices in the diagnosis of obstructive uropathy.

REVIEW OF LITERATURE

1) International journal of nephrology and renovascular diseases December 2012;5 15-21 (2012). Raza Sayani et al conducted a comparative study in patients with acute unilateral obstruction. They have evaluated the functions of urinary tract by CDUS with IVU. In their study , they considered RI value of more than 0.70 and delta RI value of more than 0.06 as diagnostic value of obstruction. They found out RI value for the obstructed kidney was significantly higher than contra lateral non-obstructed kidney. They concluded that Delta RI is more sensitive and specific than RI in acute renal obstruction

2 .Journal ultrasound medicine 2006;25;1113-1120 (2006) . Safiye Gurel et al studied 160 patients with acute renal colic and compared the sensitivity of CDUS with Non- enhanced CT in differentiating obstruction from non- obstruction. In their study, they observed Mean RI values for the obstructive and Non – obstructive samples were 0.64 and 0.63 respectively. They also observed Mean delta RI values of 0.01312 and 0.01000in the obstructive and non- obstructive groups. They found that there

was no significant relationship between the RI values , calculus location and degree of obstruction

3. journal of pakisthan medical association December 2013 63;1511 Aneela Azam et al conducted study in unilateral renal colic patients. They compared the diagnostic accuracy of CDUS with Non – enhanced CT in diagnosing obstructive uropathy. They considered RI value of >0.70 as diagnostic of obstruction. In their study, they found the sensitivity and specificity of RI were 76.23% and 88.13 % respectively.

4. Journal clinical and diagnostic research December 2014 Umamageswari studied RI , Delta RI and Resistivity Index Ratio in 72 patients with acute unilateral obstruction. She reported that the Resitivity index ratio was a better parameter in predicting the diagnosis of acute obstruction

5. Journal of ultrasound 2012 15,239-246 . E.M.S.Piazzese et al. Studied 54 patients with acute renal colic to determine whether RI can predict HUN and whether or not the performance is time dependent. They done repeated imaging every 6^{th} hourly and found RI before onset of hydronephrosis in a time- dependent manner. In their study, RI predicted the onset of acute dilatation with higher sensitivity and specificity than USG. So, they suggest

routine use of CDUS in the emergency department to supplement USG finding.

Currently, NCCT is considered the first-line imaging study for the evaluation of the patient with acute flank pain (Westphalen et al. 2011) .

Smith et al. 1996 ; Dalrymple et al. 1998 ; Vieweg et al. 1998 were reported sensitivity for diagnosing a ureteral stone in a patient with acute flank pain ranges from 95% to 98% and the specificity ranges from 96% to 98%

Doppler ultrasound can be useful to aide in the detection of stones. One sign that can be evaluated using Doppler ultrasound is the “twinkling sign” (Mitterberger et al. 2009) .

The “twinkling sign” is one of the color- flow Doppler ultrasound artifact.It appears as random color encoding in the area behind the stone where shadowing would be seen in traditional B-mode ultrasound.

In Mitterbergeret al. 2009 report, Doppler ultrasound was able to detect 97% of stones versus 66% for gray scale ultrasound.

Measurement that can improve ultrasound detection of stones and obstruction is the resistive index (RI) (Shokeir and Abdulmaaboud 2001; Gandolpho et al. 2001; Pepe et al. 2005; Andreoiu and MacMahon 2009

Kavakli et al. 2011) Using IVU as the standard, RI was shown to have a sensitivity of 88% and a specificity of 98% for ureteral obstruction (Shokeir AA, Abdulmaaboud M 1999). The RI in obstructed kidneys was significantly greater than the RI in non-obstructed kidneys, 0.73 versus 0.64 ($p < 0.001$). . The finding of ureteral jets on Doppler ultrasound can be a useful adjunct to RI in ruling out obstruction (Gandolpho et al. 2001; Andreoiu and acMahon 2009)

In a prospective study comparing NCCT and Doppler ultrasound with RI for the detection of ureteral obstruction using IVU as the standard, both NCCT and Doppler ultrasound performed equally well (Shokeir and Abdulmaaboud 2001). The sensitivity and specificity for the diagnosis of ureteral obstruction for NCCT was 96% and 96% compared to 90% and 100% for Doppler ultrasound.

Similar works about RI has been done at international and national levels previously. Mean RI of obstructed kidney was found

to be more than 0.7 by Geavlete et al, Amin et al, Ashraf et al, Platt et al and De Toledo et al. Sauvian et al found it to be 0.7 [26 – 30] whereas Hyder et al, Onur et al1 and Skokeir et al found it to be below 0.7. [31,32].

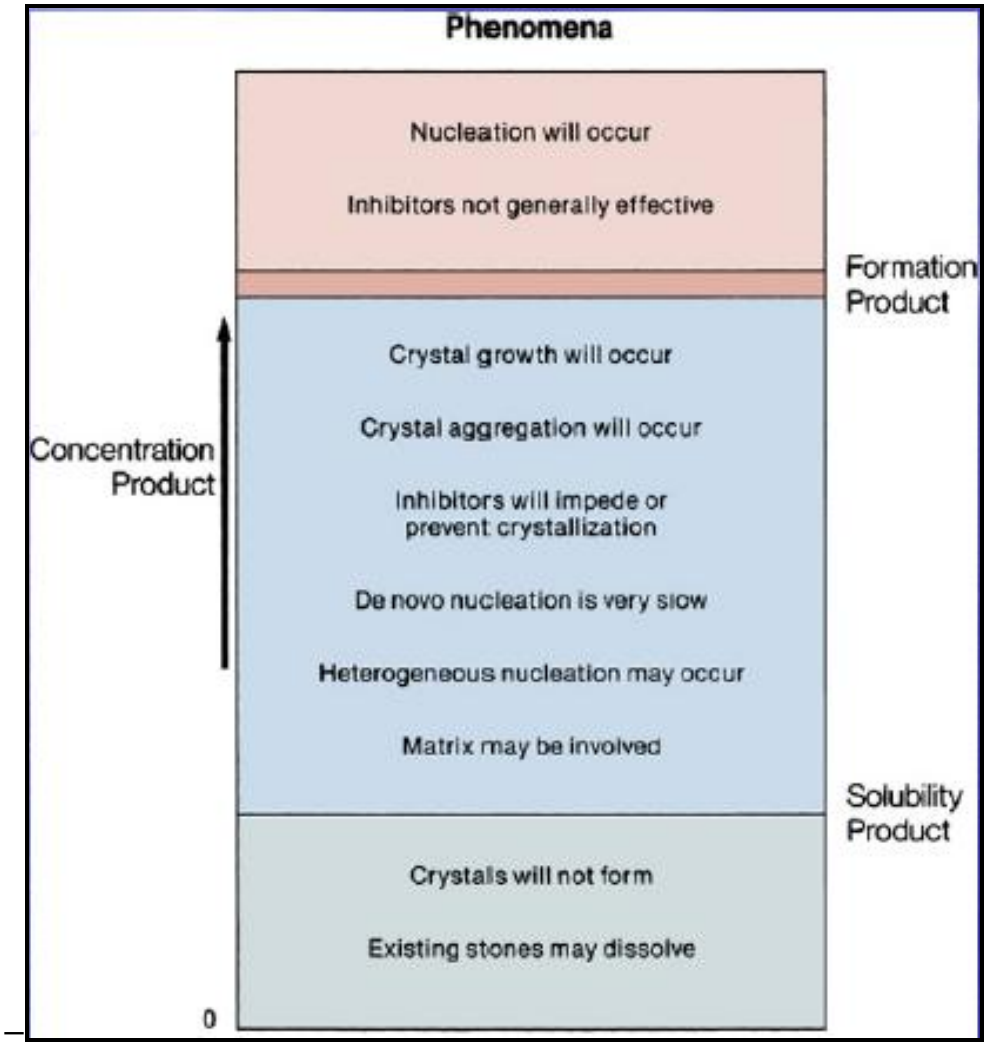
NEPHROLITHIASIS OR UROLITHIASIS

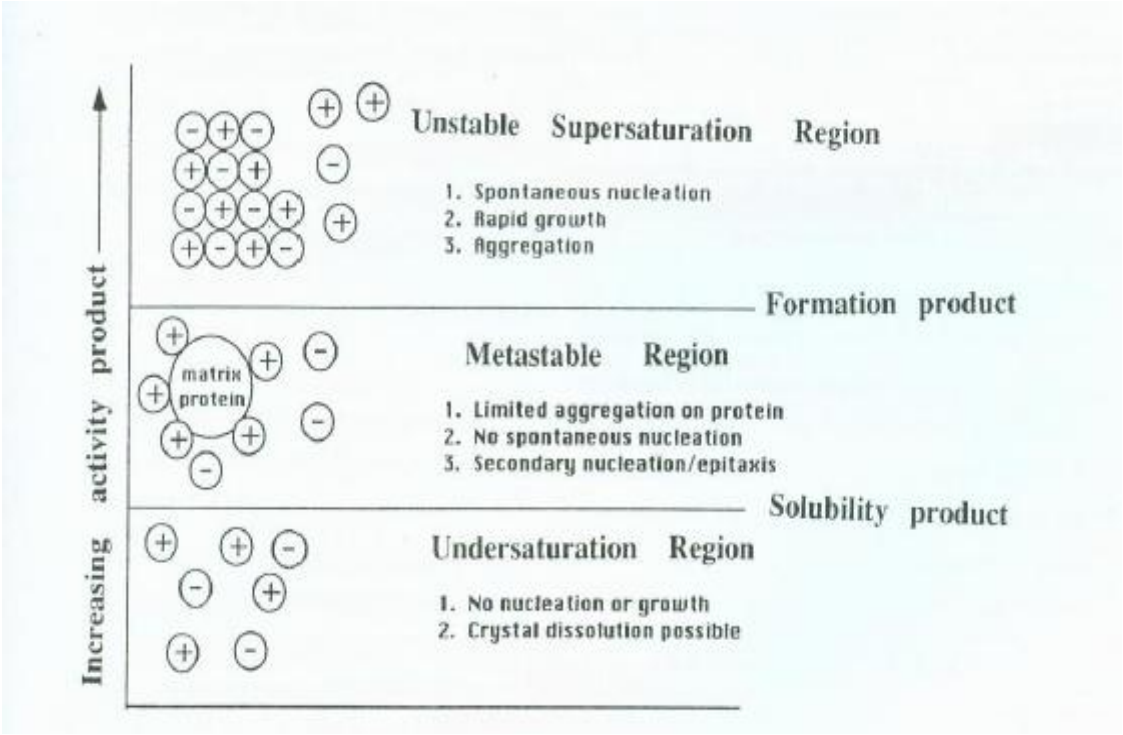
Exact mechanism of stone formation is not known. Proposed theories are as follows

1) Precipitation crystallization theory,
2) Stone matrix theory,
3) Inhibitors of crystallization theory, but the exact mechanism is not known

STAGES OF SATURATION

1) under saturation
2) Meta stable
3) 3.Un stable


Phenomena
Nucleation will occur
Inhibitors not generally effective
Formation Product
Crystal growth will occur
Crystal aggregation will occur
Inhibitors will impede or prevent crystallization
De novo nucleation is very slow
Heterogeneous nucleation may occur
Matrix may be involved
Concentration Product
Solubility Product
Crystals will not form
Existing stones may dissolve
0



INHIBITORS OF RENAL CALCULI

1. crystal growth inhibitors - Citrate, magnesium, pyrophosphate and Zinc
2. crystal aggregation inhibitors - Glycosaminoglycans, nephrocalcin and Tamm- Horsfall protein

PROMOTERS OF RENAL CALCULI

1. Bacterial infection,
2. Matrix,
3. Anatomic abnormalities,
4. Altered Ca and oxalate transport in renal epithelia,
5. Prolonged immobilization,

6. Increased uric acid levels and nanobacteria

RISK FACTORS FOR STONE FORMATION

1) presence of bowel disease,

2) excess dietary meat, oxalate, sodium consumption,

3) family history of stone formation,

4) insulin resistance, gout, obesity,

5) primary hyperparathyroidism,

6) prolonged immobilization

7) Renal tubular acidosis

Metabolic Abnormalities Predisposing to Nephrolithiasis

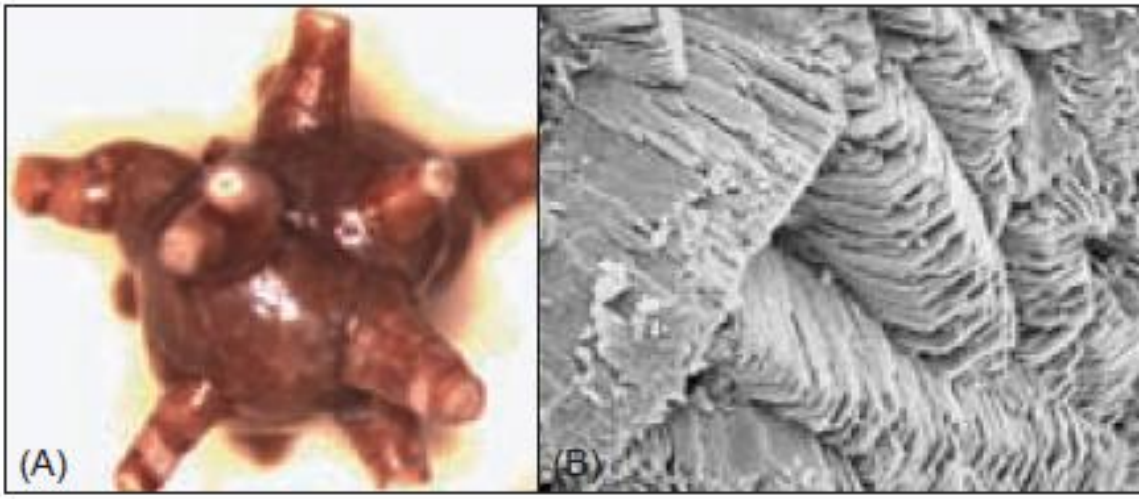
	Concentration
Urine volume (ML/24h)	<2000
Sodium (mEq/24 h)	>140
Calcium (mg/24 h)	>300 (>250 for females)
Uric acid (mg/24 h)	>700
Oxalate (mg/24 h)	>45
Citrate (mg/24 h)	<320
Cystine (mg/g creatinine/24 h)	>60
Urinary pH	>5.5
Creatinine (mg/kg/24h)	>25 (>20 for females)

Diagnostic classification of stone disease;

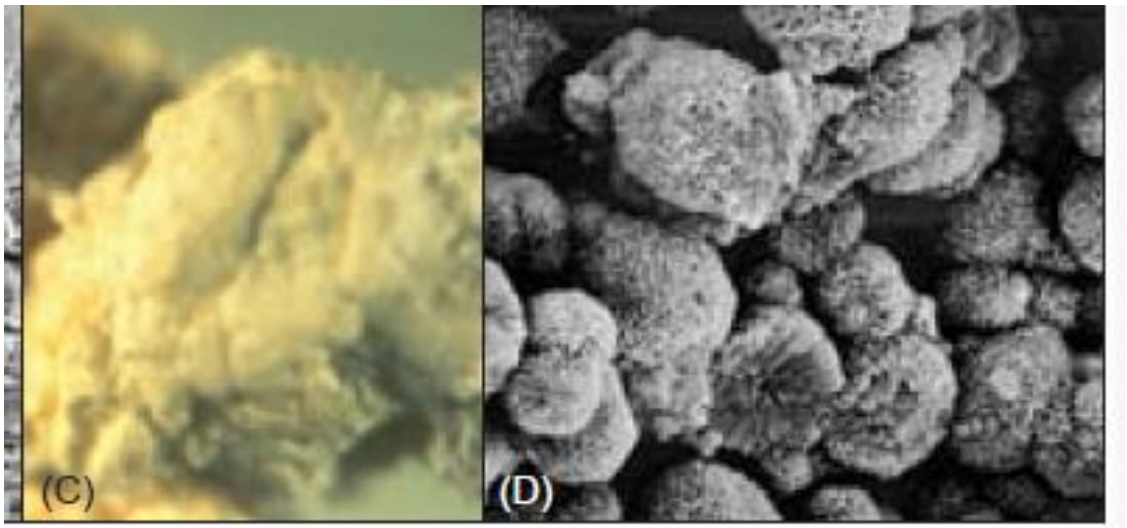
CONDITION	METABOLIC/ENVIRONMENTAL DEFECT	PREVALENCE (%)
Absorptive hypercalciuria		20-40
Type I	Increased gastrointestinal calcium absorption	
Type II	Increased gastrointestinal calcium absorption	
Renal phosphate leak	Impaired renal phosphorus absorption	
Renal hypercalciuria	Impaired renal calcium reabsorption	5-8
Resorptive hypercalciuria	Primary hyperparathyroidism	3-5
Hyperuricosuric calcium nephrolithiasis	Dietary purine excess, uric acid overproduction	10-40
Hypocitraturic calcium nephrolithiasis		10-50
Isolated	Idiopathic	
Chronic diarrheal syndrome	Gastrointestinal alkali loss	
Distal renal tubular acidosis	Impaired renal acid excretion	
Thiazide-induced	Hypokalemia	
Hyperoxaluric calcium nephrolithiasis		2-15
Primary hyperoxaluria	Oxalate overproduction	
Dietary hyperoxaluria	Increased dietary oxalate	
Enteric hyperoxaluria	Increased intestinal oxalate absorption	
Hypomagnesiuric calcium nephrolithiasis	Decreased intestinal magnesium absorption	5-10
Gouty diathesis	Low urinary pH	15-30
Cystinuria	Impaired renal cystine reabsorption	<1
Infection stones	Infection with urease-producing bacteria	1-5
Low urine volume	Inadequate fluid intake	10-50
Miscellaneous or no abnormality	NA	<3

CALCIUM OXALATE (WHEWELLITE OR ‘MULBERRY’STONES)

Calcium oxalate monohydrate crystals - dumbbell-shaped

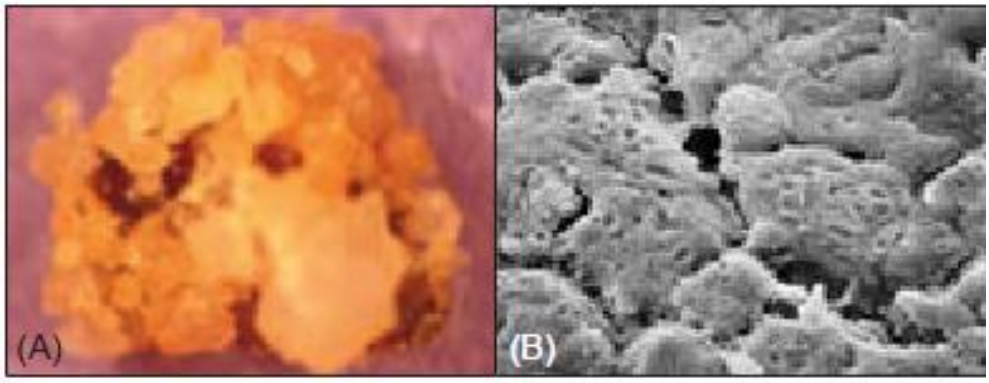


Calcium phosphate apatite crystals - irregular in shape

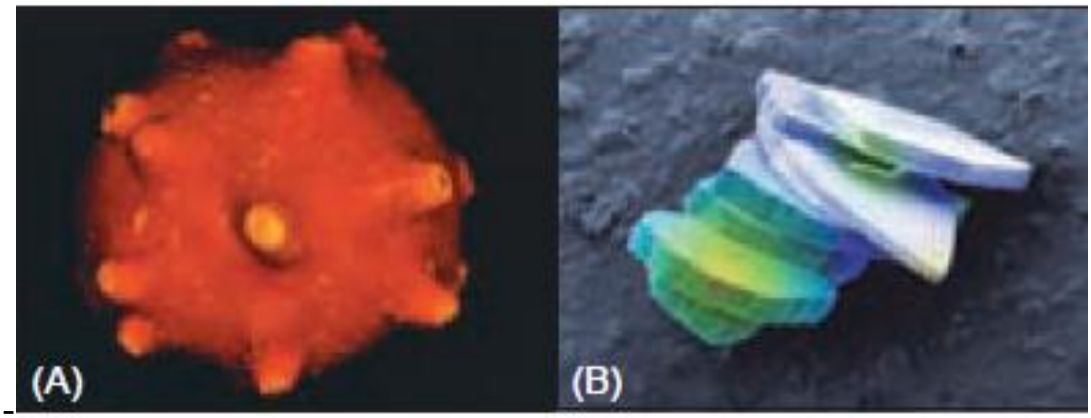


MAGNESIUM AMMONIUM PHOSPHATE

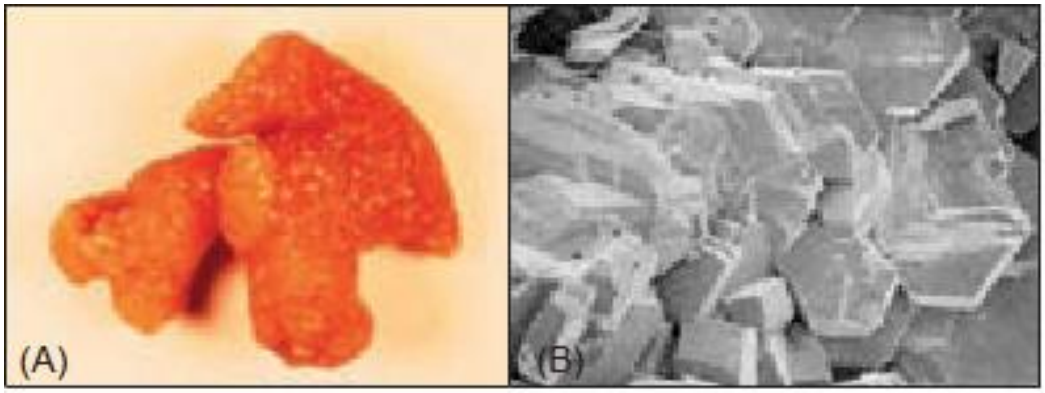
Stones (triple phosphate or struvite stone) - coffin-lid appearance



Uric acid stones- Irregular plates or rosettes



cystine stone- benzene ring or Hexagonal crystal



OBSTRUCTIVE UROPATHY

Defined as a “the structural impedance to the flow of urine anywhere along the urinary tract leading to ‘hydronephrosis’, which is the dilation of the renal pelvis and calyces.”

OBSTRUCTIVE NEPHROPATHY:

defined as a **“**damage to the renal parenchyma that results from an obstruction to the flow of urine anywhere along the urinary tract”

Mechanism of Obstructive Nephropathy are unveiled at genetic, molecular , cellular, glomerular , renal tubular, whole kidney, and systemic levels

TYPES OF OBSTRUCTION

Basesed on point of obstruction;

1. Proximal level – example Calyceal obstruction

2. Distal level - example urethral meatal obstruction

Based on cause of obstruction;

1. Congenital or Acquired obstruction

2. Benign or Malignant

Global functional renal functional changes

- Functional changes produced by the obstructive nephropathy in turn affect the renal hemodyanamic variables and glomerular filtration
- Obstruction can transiently or permanently alter GFR

Factors influencing the impact of obstruction

1) Degree of obstruction

    1. Partial or complete

    2. Unilateral or bilateral

2) Duration of obstruction

    1 Acute obstruction

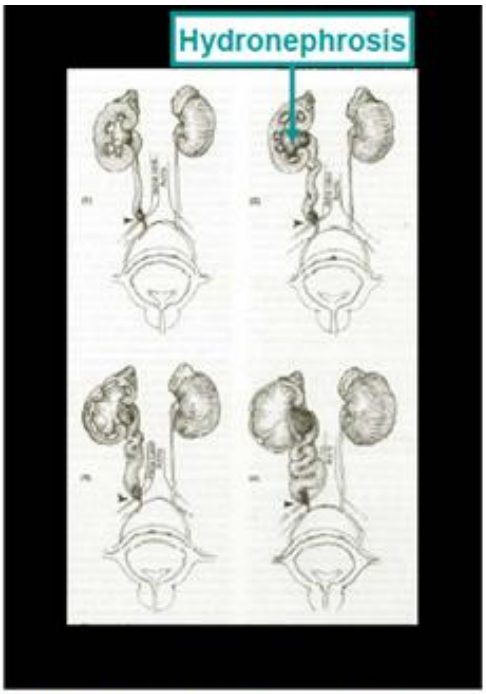
    2. Chronic obstruction

3) Baseline condition of the kidneys,

4) The potential for recovery,

5) The presence of other mitigating factors such as urinary infection

PATHOPHYSIOLOGY OF URINARY TRACT OBSTRUCTION



Mechanical or functional obstruction

Back up of urine flow = increased renal pressure

Tubular dilatation

Initial increase in renal blood flow

Decrease in renal blood flow

Increase in renal lymphatic flow

Initial increase in ureteral peristalsis & pelvic muscle hypertrophy

Muscle stretched & atonic → Aperistalsis

Dilatation of ureters and renal collecting duct system

Parenchymal Atrophy

Renal failure

5

HOW ACUTE OBSTRUCTION LEADS TO DILATATION AND DECREASED TUBULAR FUNCTION ?

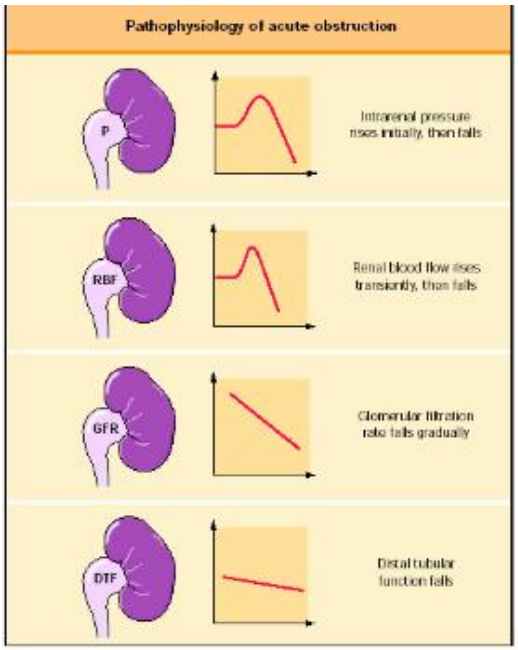
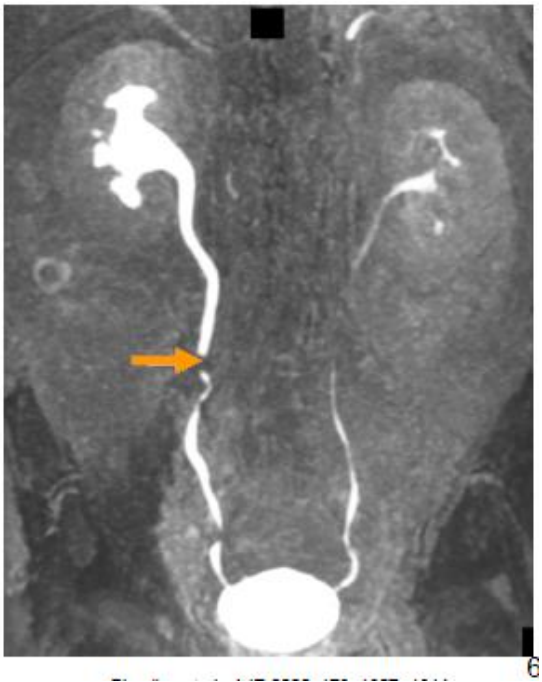


Fig. 23.2 Pathophysiology of acute obstruction.

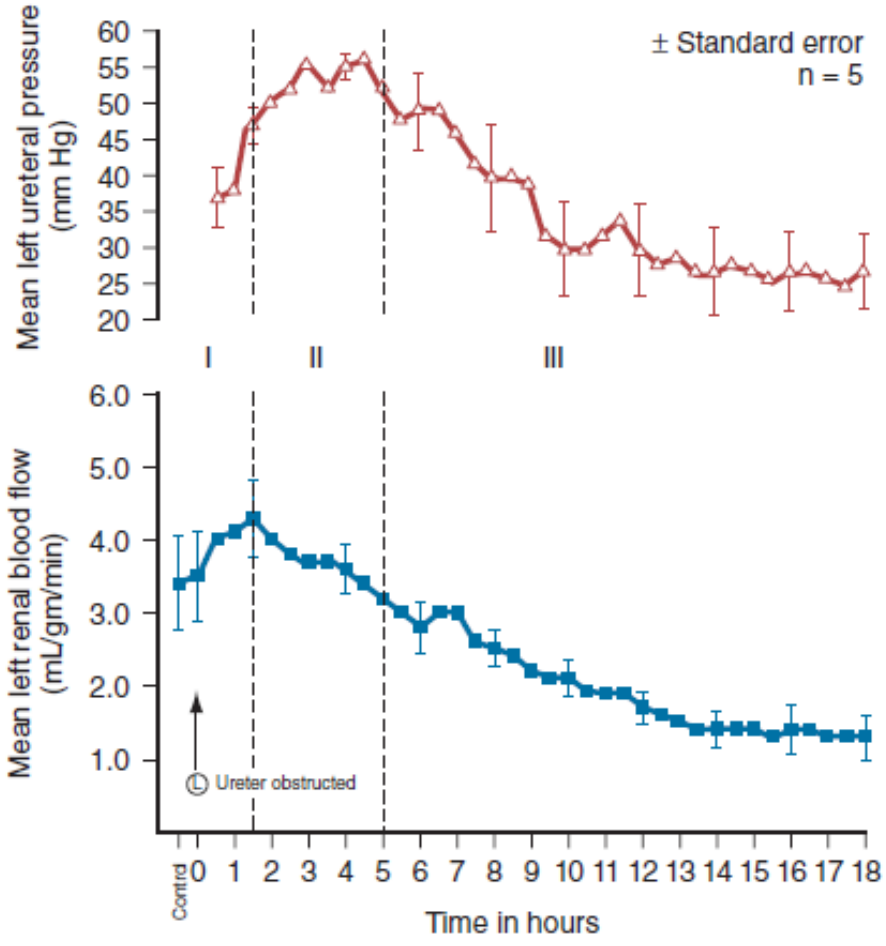


6

HEMODYANAMIC CHANGES WITH UNILATERAL URETERAL OBSTRUCTION

- Triphasic pattern of RBF and ureteral pressure changes in unilateral obstruction that differs from bilateral ureteral obstruction or unilateral obstruction of a solitary kidney

Diagram showing Triphasic relationship between ipsilateral renal blood flow and left ureteral pressure during 18 hours of left-sided occlusion.

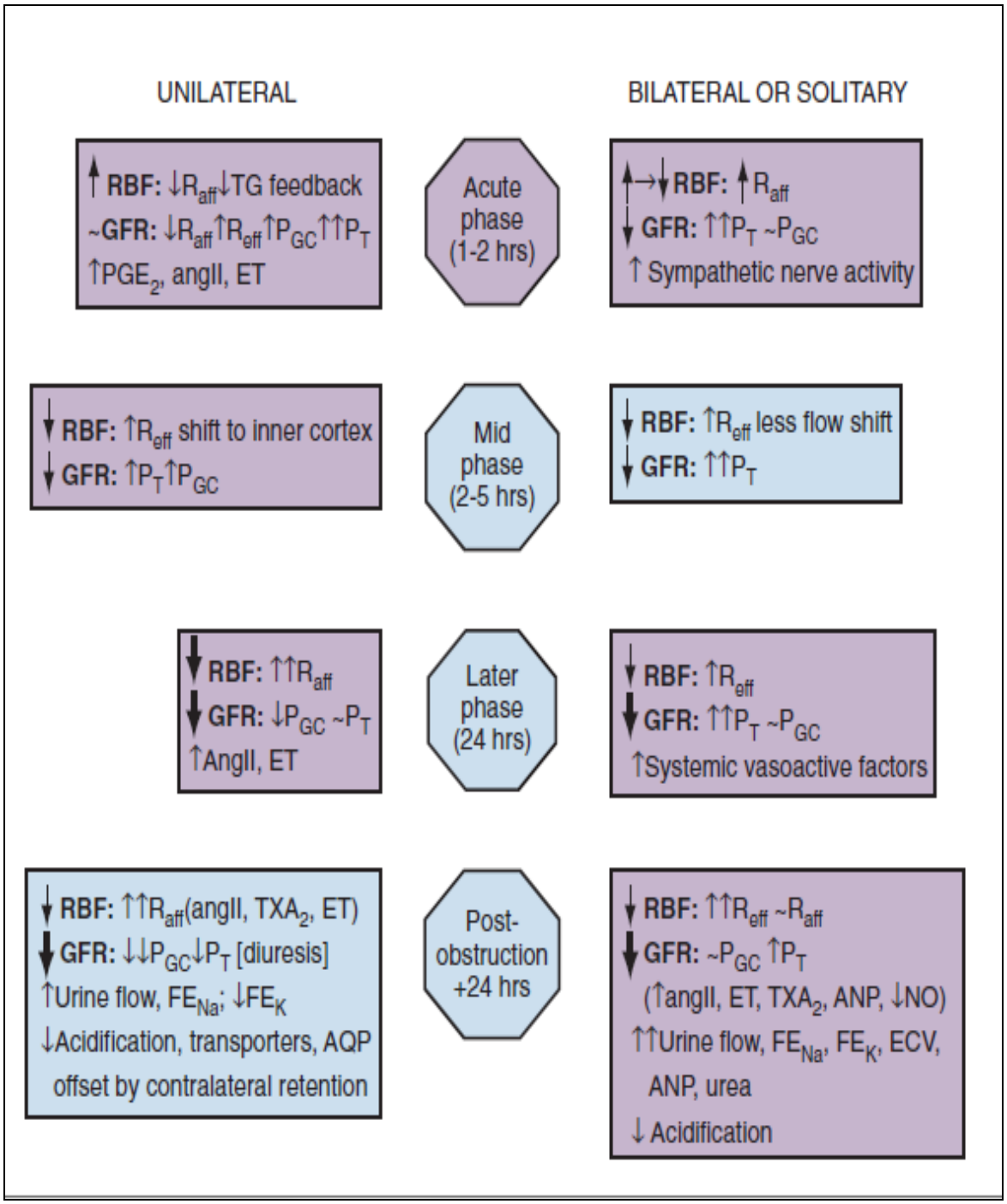


- In Phase 1 – renal blood flow and ureteral pressure rise together.
- In phase II- left renal blood flow begins to decline and ureteral pressure continues to rise.
- In phase III - left renal blood flow and ureteral pressure decline together

MEDIATOR INVOLVED

1) Eicosanoids (prostaglandins and thromboxane),
2) Angiotensin II (AII),
3) Nitric oxide (NO),
4) Endothelin

Difference between bilateral ureteric obstructions (BUO)from unilateral ureteric obstruction (UUO).



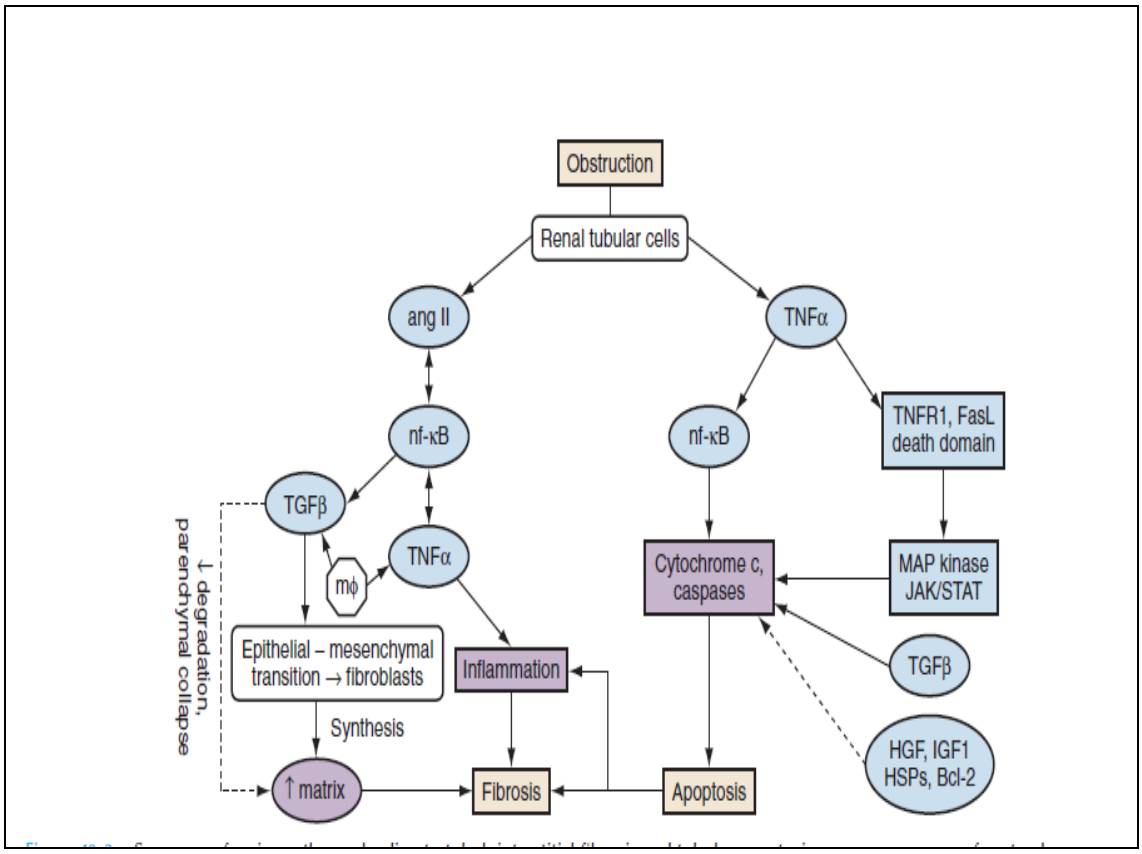
Both UUO and BUO involve increases in renal vascular resistances and increases in ureteral pressures. However, the timing and regulation of these changes differ .

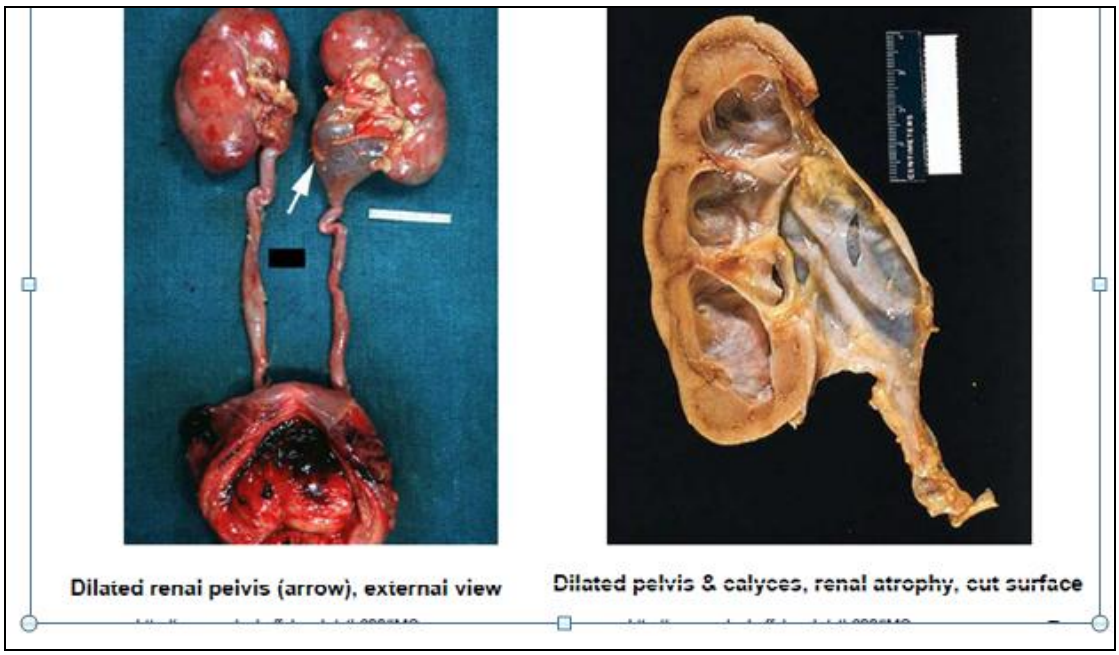
1) With UUO, early renal vasodilation primarily mediated by prostaglandins and NO is followed by prolonged vasoconstriction and normalization of intratubular-ureteral pressure as the contralateral kidney contributes to fluid balance.

2) With BUO, little early vasodilation is seen, and vasoconstriction is more profound. When the obstruction is released, the postobstructive diuresis is much greater

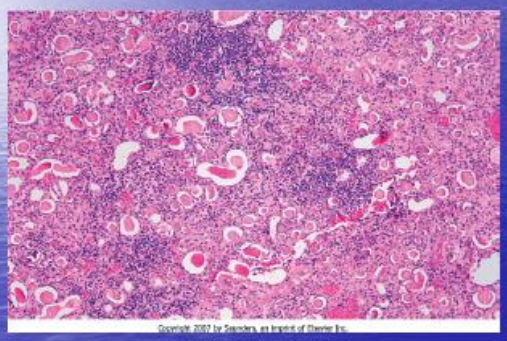
3) With BUO because volume expansion, urea and other osmolytes, and secreted ANP contribute to a profound diuresis and natriuresis

Major Pathways leading to tubulointerstitial fibrosis and tubular apoptosis as a consequence of ureteral obstruction





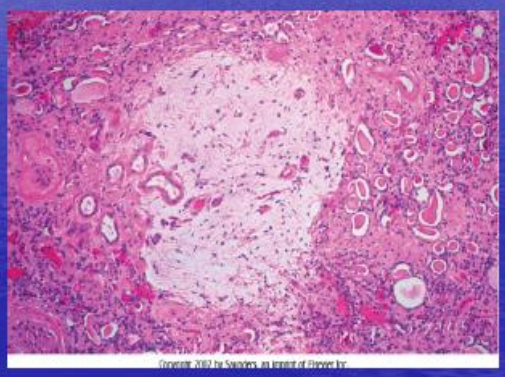
Pathologic changes of obstruction



- lymphatic dilation, interstitial edema
- Collecting duct and tubular dilatation
- Widening of Bowman's space, tubular basement membrane thickening, cell flattening, and cytoplasmic hyalinization
- Inflammatory cell response

Pathologic changes

- Interstitial fibrosis and thickening of the tubular basement membranes
- Cortical thinning and development of glomerular crescents were present at the 3- to 4-week interval



PROTECTIVE MECHANISMS IN OBSTRUCTION

1) Pyelosinus extravasation

2) Pyelolymphatic extravasation

3) Pyelotubular extravasation

4) Pyelovenous extravasation

5) Forniceal rupture

6) Compensatory hypertrophy of contralateral kidney

POST OBSTRUCTIVE DIURESIS

Refers to “the marked polyuria that occurs after the relief of BUO or obstruction of a solitary kidney”

- Usually seen in chronic obstruction, volume overload and rarely with uremic encephalopathy.
- Patients will have both solute diuresis and concentrating defect.
- Solute dieresis is due to retained sodium,water and urea
- Concentrating defect is due to high atrial natriuretic peptide levels and impaired renal response to vasopressin

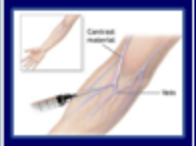
MANAGEMENT OF ACUTE HYDRONEPHROSIS

Aims of Imaging in acute hydronephrosis are to distinguish between obstructive and non-obstructive dilatation, the localization and extent of the obstructed area must also be determined in order to avoid unnecessary surgery.

The early diagnosis and release of obstruction are essential if irreversible damage in the affected kidneys is to be prevented.

IMAGING METHODS USED IN THE DIAGNOSIS OF URETERAL OBSTRUCTION

Imaging modality	Sensitivity (%)	Specificity (%)	Advantages	Limitations
Ultrasonography 	19	97	Accessible Good for diagnosing hydronephrosis and renal stones Requires no ionizing radiation	Poor visualization of ureteral stones
Plain radiography 	45–59	71–77	Accessible and inexpensive	Stones in middle section of ureter, phleboliths, radiolucent calculi, extraurinary calcifications and nongenitourinary conditions

Imaging modality	Sensitivity (%)	Specificity (%)	Advantages	Limitations
Intravenous pyelography 	64–87	92–94	Accessible. Provides information on anatomy and functioning of both kidneys	Variable-quality imaging. Requires bowel preparation and use of contrast media. Poor visualization of nongenitourinary Conditions.
Noncontrast helical computed tomography	95–100	94–96	Most sensitive and specific radiologic test . Indirect signs of the degree of Obstruction. Provides information on nongenitourinary conditions	Less accessible and relatively expensive. No direct measure of renal function.

RADIATION LEVELS IN THE IMAGING MODALITIES

Imaging	Radiation Exposure (mSV)
X Ray - KUB	0.5 - 1
IVU	1.3 - 3.5
Regular dose NCCT	4.5 - 5
Enhanced CT	25 - 35
Low dose NCCT	0.97 - 1.9

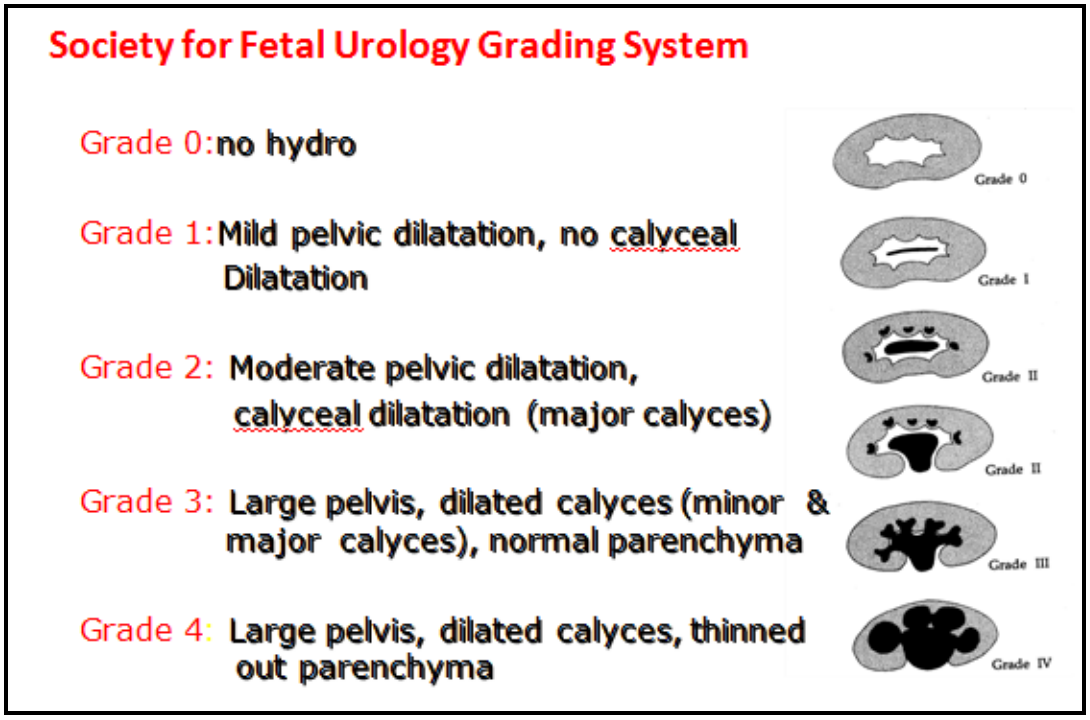
USG GRADING OF HYDROURETERO NEPHROSIS SOCIETY FOR FETAL UROLOGY GRADING SYSTEM

1) Grade-O: No hydro grade 1;mild pelvic dilatation ,no calyceal dilatation

2) grade-2: Moderate pelvic dilatation ,calyceal dilatation (major calyces)

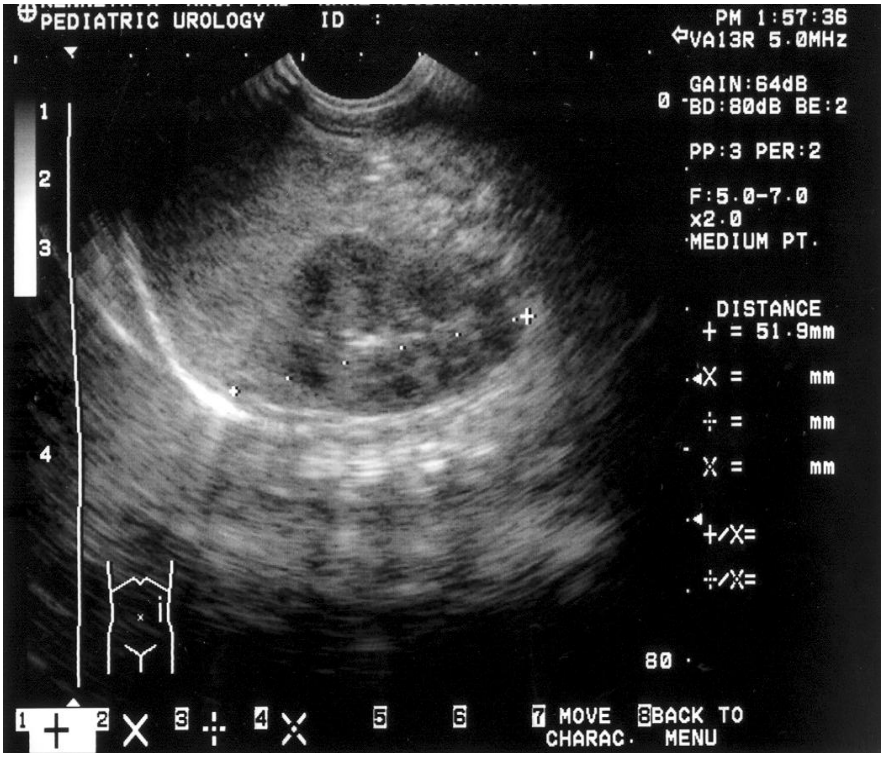
3) grade-3: Large pelvis, dilated calyces(minor &major calyces), normal parenchyma

4) grade-4: Large pelvis ,dilated calyces ,thinned out parenchyma.

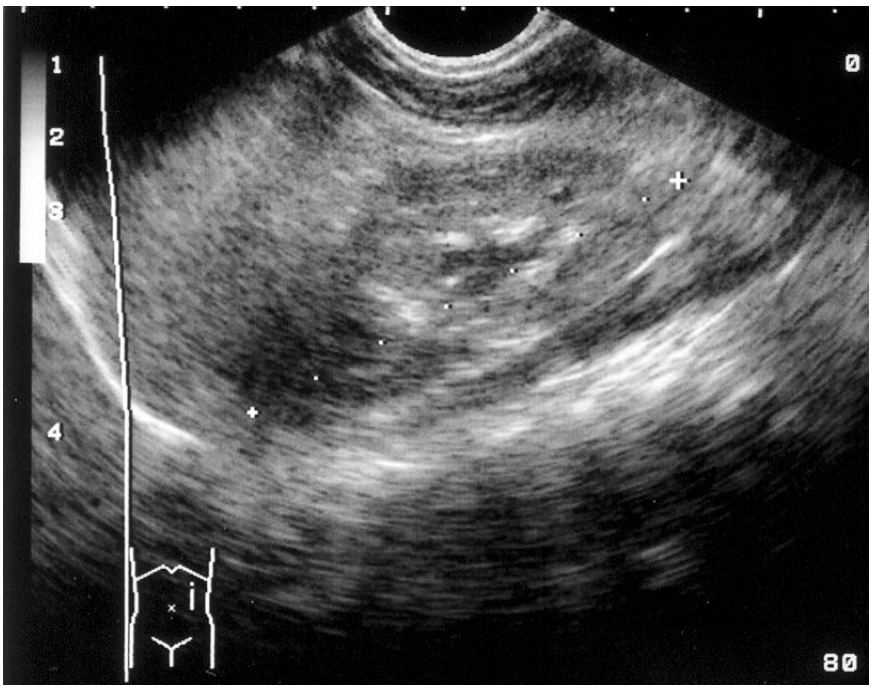


ULTRASOUND IMAGES OF HYDROURETERONEPHROSIS

Grade o –no hydronephrosis



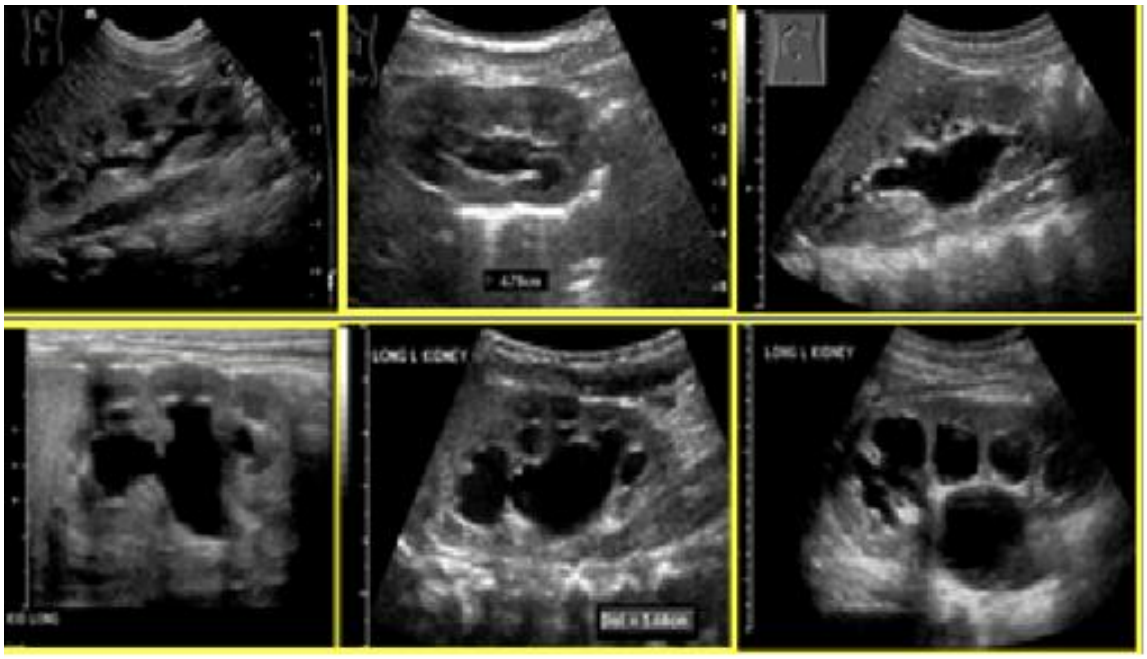
SFU Grade 1 (Pelviectasis/ no calyceal dilatatio)



Hydronephrosis – 2 & 3

Grade 2 – moderate pelvic dilatation & Only Major cayceal dilatation

Grade 3 – Large pelvis & Both major and minor calyceal dilatation

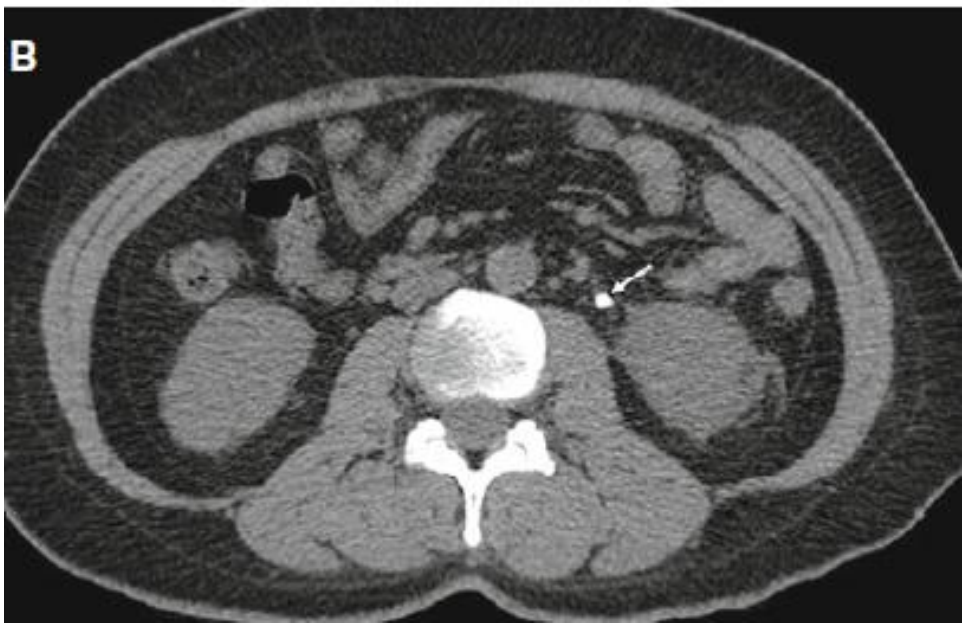


Hydronephrosis (Grade - 4)

COMPUTED TOMOGRAPHY CT KUB

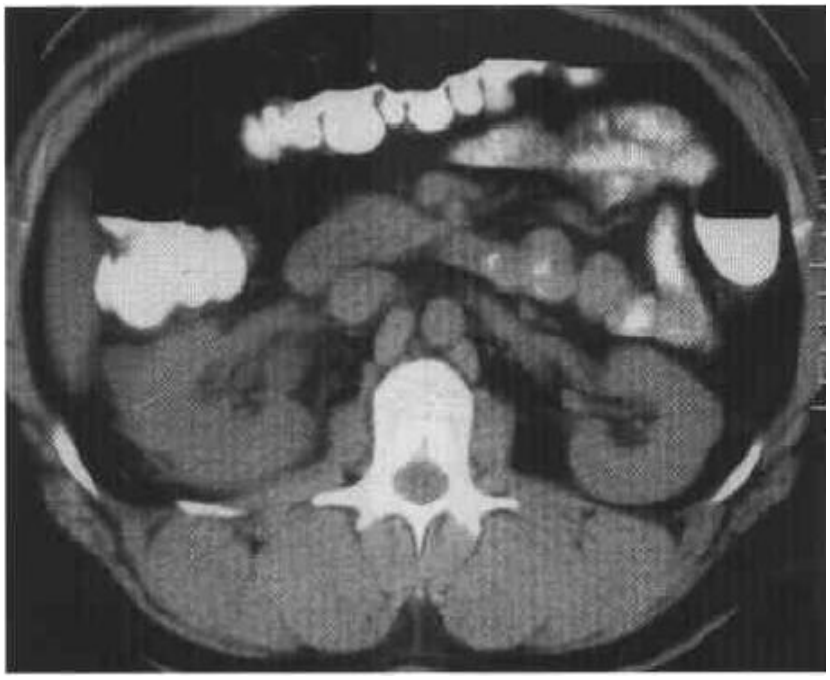
Newer introduction of Multi detector CT (MDCT) and Dual energy CT DECT) made CT as the superior modality over other imaging in the diagnosis of stone disease.

MDCT accurately detect the stones than axial images alone. Non- enhanced CT will diagnose, almost 99% of stones including radiolucent stones except Matrix and Indinavir stones . CT numbers (Hounsfield units) are helpful in the management of stone patients.



Nonenhanced transverse and reformatted coronal CT reveal a stone in the left upper ureter (arrow).

Nonenhanced coronal CT shows a mild dilatation of ureter and pelvocalyces proximal to the stone (arrowheads). The presence of stone in the urinary track is the primary (direct) sign of urolithiasis in CT images



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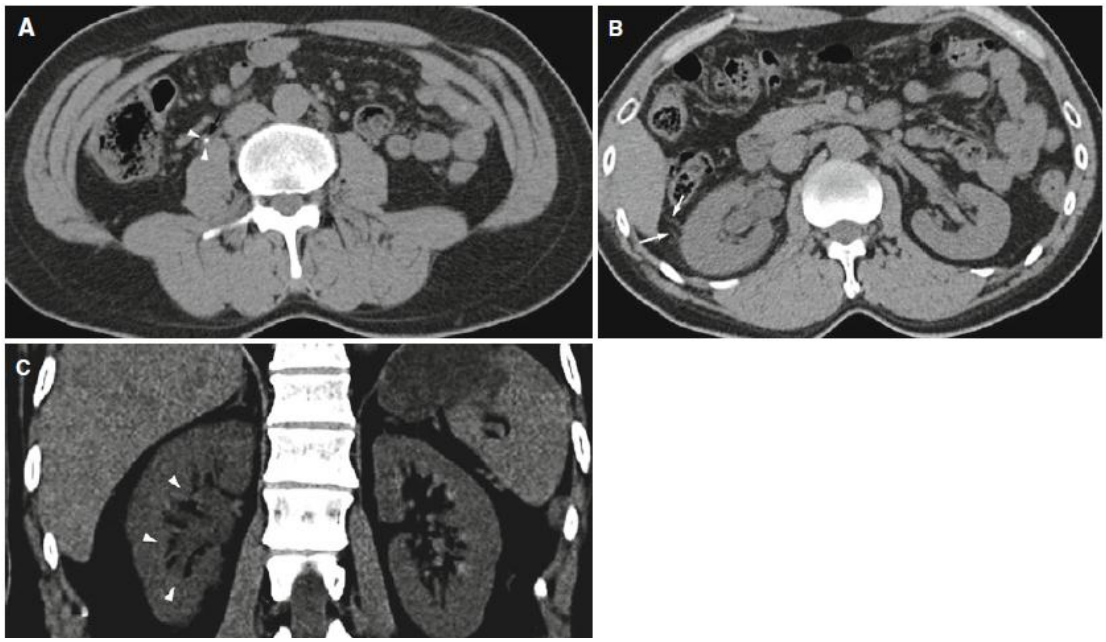
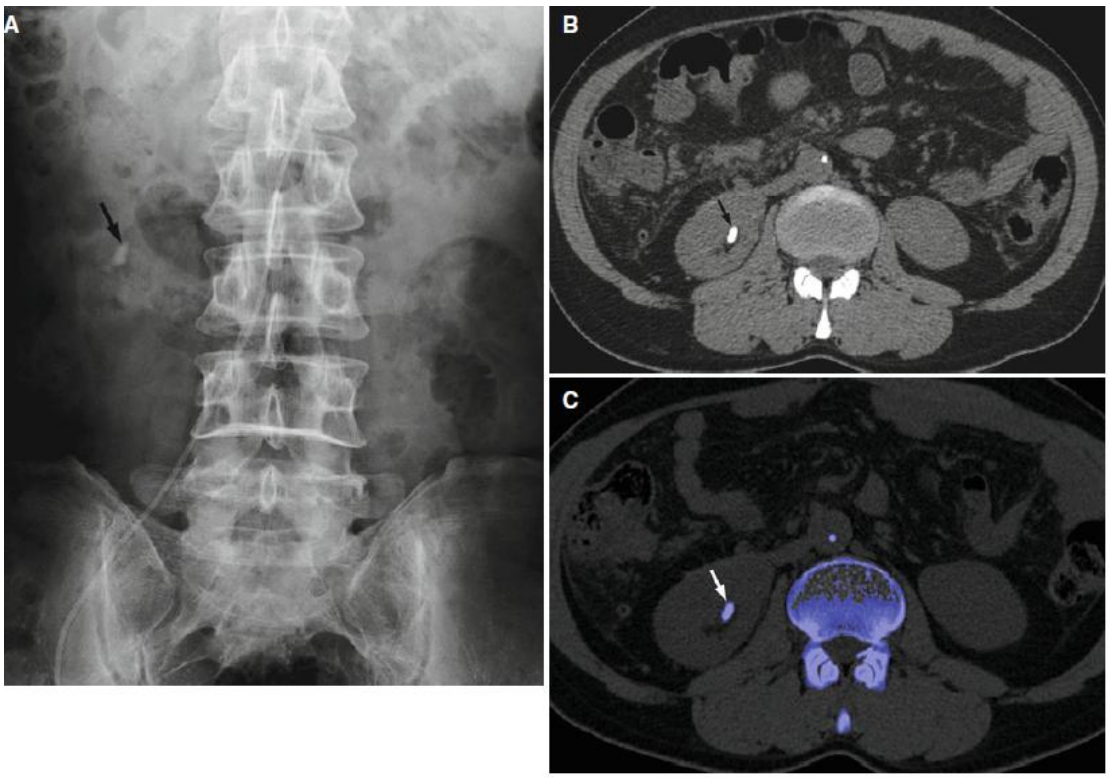
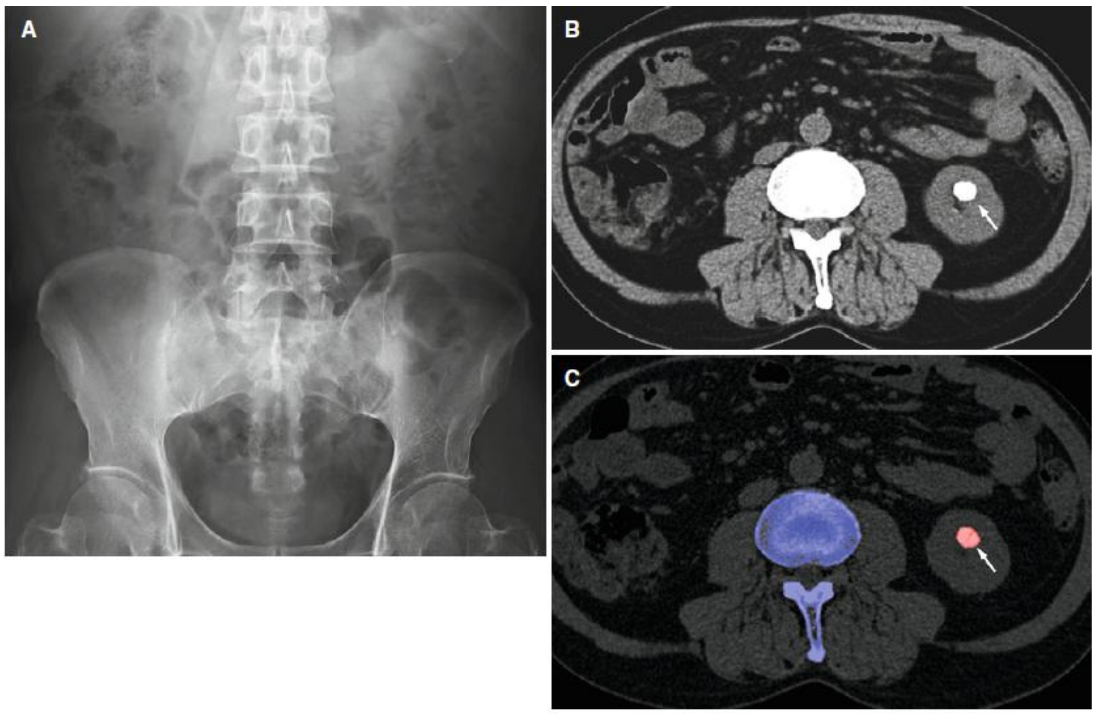


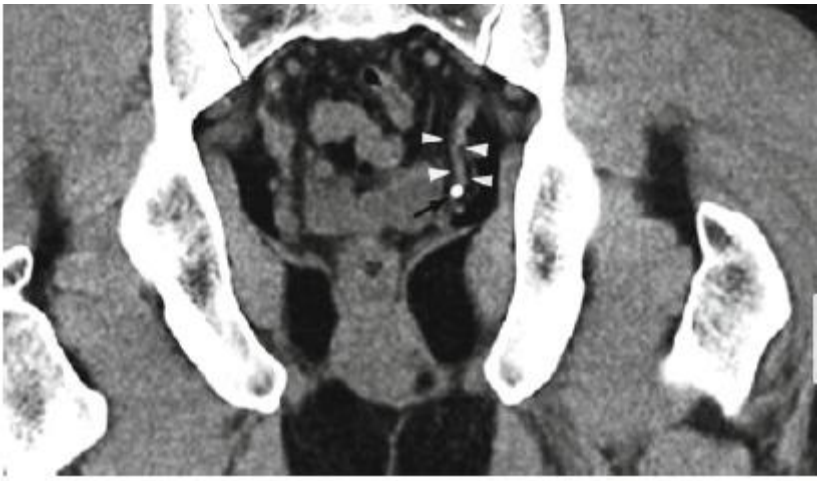
Secondary signs of ureter stone in a 51-year-old man. (A) Nonenhanced CT of mid abdomen level shows a ureter stone (arrow). Note the soft tissue surrounding the stone, suggesting a thickened ureteral wall and periureteral edema (arrowheads). (B and C) Nonenhanced transverse (B) and reformatted coronal (C) CT demonstrate that the right kidney shows hydronephrosis and enlargement. Note the perinephric stranding (arrows) and absence of a white renal pyramid in the right kidney (arrowheads). These findings are secondary signs of a ureter stone.



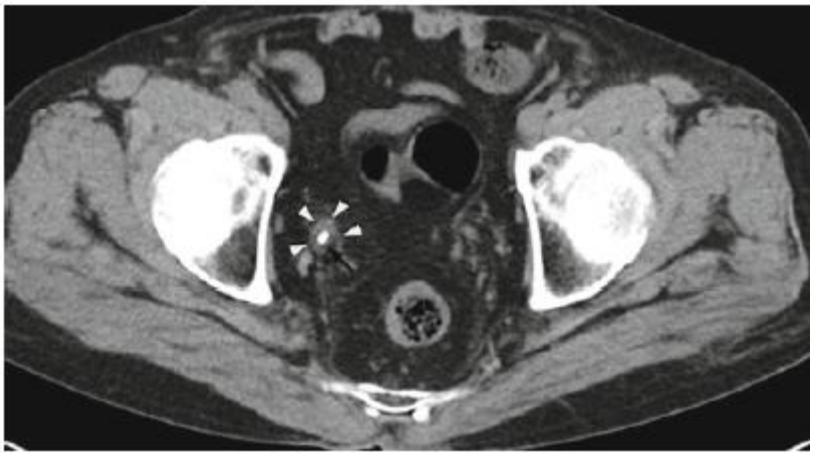
A calcium stone on DECT in a 46-year-old man. (A) Plain radiograph shows small calcification (arrow) in the lower polar region of the right kidney. (B and C) Nonenhanced CT (B) reveals a stone (arrow) in the right kidney. Postprocessing image of DECT shows the blue color of the stone, suggesting calcium stone. Note similar color of the spine with a calcium component.



A uric acid stone on DECT in a 59-year-old man. (A) Plain radiograph shows no defi nite calcifi cation in both kidneys. (B and C) Nonenhanced CT (B) reveals a stone (arrow) in the left kidney. Postprocessing image of DECT shows pink color of the stone, suggesting uric acid stone. DECT and the differences in the radiograph attenuation properties at high and low kilovolts allow accurate renal stone differentiation between uric acid–containing stones and calcium-contained stones.



A phlebolith in a 39-year-old man. Nonenhanced coronal CT shows a small calcifi cation (arrow) with a linear soft tissue (arrowheads), suggesting comet tail sign.



Nonenhanced transverse CT shows a small calcifi cation (arrow) on the right pelvic cavity. Note the surrounding soft tissue (arrowheads), suggesting ureteral and periureteral edema and/or infl ammation due to stone. This fi nding is called a soft rim sign of stone.

DOPPLER USG

1. Invasive, pain less, easy to perform and learn
2. Provides both morphological and hemodynamic analysis.
3. We can get data like blood flow velocities and volume from Doppler
4. Renal indices can be calculated from blood flow velocities obtained from spectral Doppler
5. Indices are used to know about the renal perfusion and used to differentiate renal Patho physiological conditions
6. They represent an indirect estimate of resistance present in the vessels

RESISTIVE INDEX (POURCELOT)

Most commonly used index which is calculated by (Peak systolic Velocity – End Diastolic velocity)/ Mean systolic velocity

DELTA RI

Calculated from the difference in RI between the obstructed kidney nd the contra lateral normal kidney

FACTORS AFFECTING THE RENAL RESISTIVE INDEX

1) Extremes of age I is higher in young children and aged more than 60 Years

2) Extremes of pulse and blood pressure

3) Hydration status

4) Left ventricular Hypertrophy and carotid intimal thickening

5) Extra renal compression by hematoma or fluid collection any space occupying lesion

6) Manual compression through transducer - Iatrogenic increases in RI

7) Renal Medical disease- It may be difficult to diagnose unilateral obstruction

8) During early stage of pre clinical diabetic nephropathy, RI found to be below normal values, whereas RI turns to be in elevated Level, once nephropathy becomes established

9) Hypertension and Chronic renal failure

10) Renal artery stenosis

11) Renal vein thrombosis

PIT FALLS IN INTRA RENAL RESISTIVE INDEX

1) Severe hydronephrotic kidney not exhibiting any elevation of RI, despite of obvious obstruction in chronic high grade obstruction. It can be due to

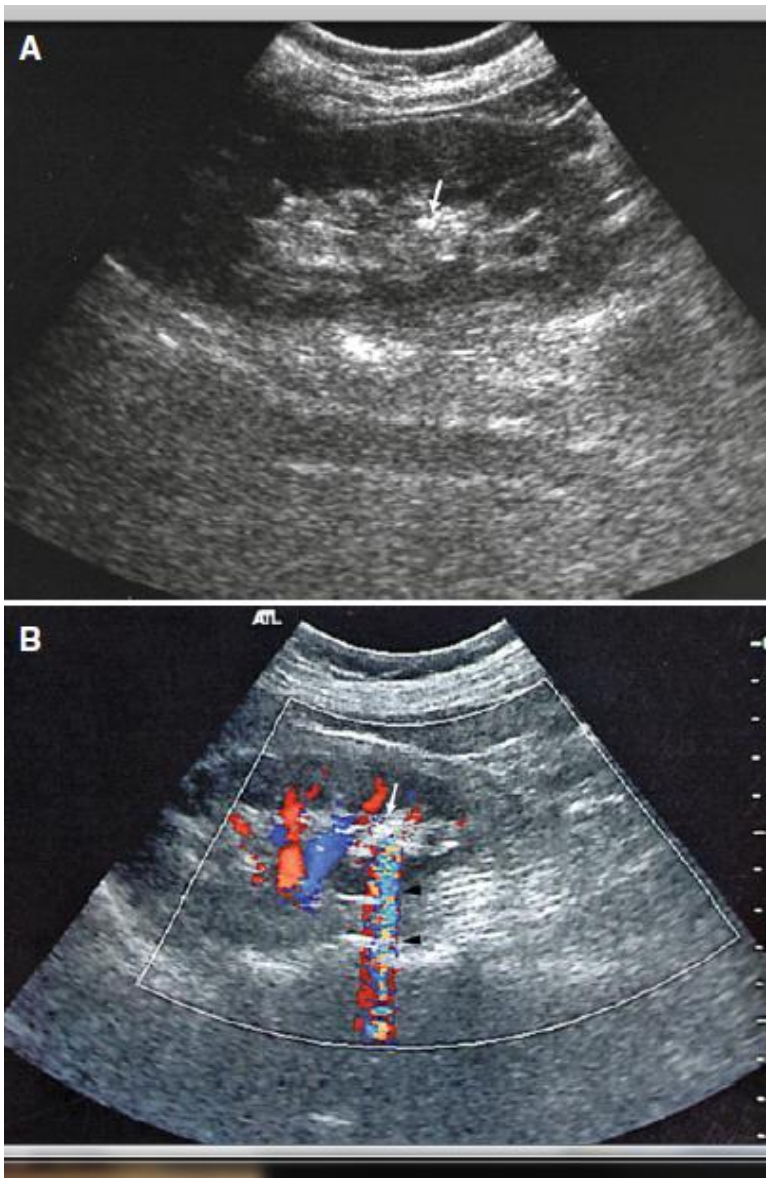
   a. Decrease in absolute blood flow,

   b. Decreased filtration pressure produced by thin renal cortex,

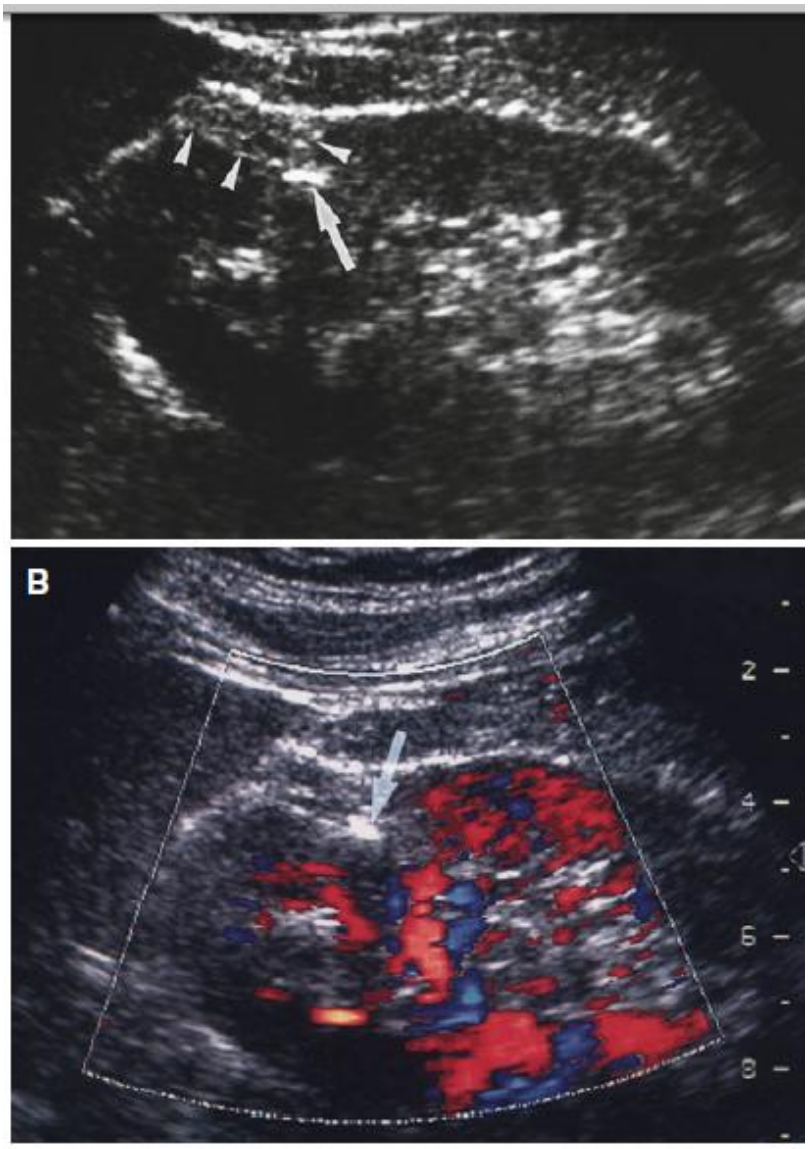
   c. elevated compliance in a capacious dilated collecting system

2) Partial ureteral obstruction had normal RI

3) The fixed biphasic response to acute obstruction may not occur consistently in clinical practice. RI might not elevate even the intermittent obstruction persists for days



(A) Longitudinal US of the right kidney shows an echogenic lesion (arrows). Sonic shadowing is not evident posterior to the echogenic lesion. (B) Color Doppler US shows strong twinkling artefact (arrowheads) posterior to the echogenic lesion (arrows), indicating that the echogenic lesion is a stone.



Longitudinal US of the left kidney shows a stone (arrow) with posterior sonic shadowing in the upper polar region. Note parenchymal scar (arrowheads) adjacent to the stone. (B) Color Doppler US of the left kidney shows decreased vascularity around the stone (arrow) due to parenchymal scarring.

MATERIALS AND METHODS

TYPE OF STUDY

Descriptive study

PLACES OF STUDY

Government Kilpuk Medical college hospital & Government Royapettah hospital, Chennai

STUDY PERIOD

Aug 2013 - Mar 2015

INCLUSION CRITERIA

1) Age 20 to 60 years of either gender

2) Unilateral flank pain

3) Patients who gave informed consent for the study were included

EXCLUSION CRITERIA

1) Children under 15 years of age (because of CT radiation risks),

2) Patients older than 60 years (because of increased risk of atherosclerosis that affects Doppler findings),

3) Patients having bilateral flank pain,

4) Pregnant patients,

5) Patients with renal , HT, DM cardiac & Metabolic diseases

6) Known case of urolithiasis,

7) Patient having solitary kidney, and transplanted kidney.

METHOD OF STUDY :

After taking approval from institutional board and ethical committee, the descriptive study was conducted at the Department of Radiology, KMC, Chennai, from August 2013 to May 2015. Taking Alpha at 5%, power 80%, sensitivity as 92% and specificity of 88% a minimum of 160 patients were required for the our study. The sampling technique was non-probability, purposive sampling.

During the study period, patients presenting with unilateral loin pain to emergency department causality KMC and royapettah were examined. After initial Clinical Examination, further evaluations were done, as follows:

1) Basic blood investigation

2) cardiologic examination;

3) X - Ray KUB

4) Abdominal US

Patients of either gender, between 15-50 years of age, who gave informed consent for the study and had unilateral colic, were included. Informed consent from the guardian of patients under 18 years of age was also taken. Those excluded were children under 15 years of age (because of CT radiation risks), patients older than 50 years (because of increased risk of atherosclerosis that affects Doppler findings), patients having bilateral flank pain, pregnant patients, patients with known renal disease, known case of urolithiasis, patients having solitary kidney, and transplanted kidney.

All the 200 patients were enrolled for this study were evaluated with bilateral color Doppler ultrasound and Plain CT KUB –Reconstructed images. The reports have been documented in the proforma .CT scan results were taken as gold standard with which Doppler USG findings wer compared.

TECHNIQUE OF DOPPLER ULTRASONOGRAPHY

- Patients should be well hydrated and urethral catheterisation done to prevent bladder pressure artifacts

- All patients were examined by single machine Nemio-18 with a curvilinear transducer of 3.5-5 MHz.

- The Doppler sample volume is set to 2mL at 5 mm and placed at corticomedullary junction of the kidney (Arcuate arteries) or along the border of medullary pyramids (interlobar arteries). These extremely small vessels have relatively low velocities with associated small frequency shifts

- Doppler waveforms were recorded from interlobar and arcuate arteries at the upper, middle and lower portions first over the obstructed then over the contra lateral kidney.

- The lowest possible pulse repetition frequency without aliasing and the highest possible gain were used.

The **renal RI** was calculated by subtracting the peak diastolic velocity from the peak systolic velocity and dividing the result by the peak systolic velocity. **Renal RI >0.7 was considered diagnostic of obstructive uropathy**.

The same procedure repeated over the contralateral normal kidney and resisitive index was observed. The difference in resistive index between the obstructed kidney and the normal

contralateral kidney was taken as **delta RI.Delta RI >0.06 was taken as a diagnostic of obstructive uropathy.**

All patients subsequently underwent unenhanced CT KUB examination on the same day within 12 hours of the US examination. Scanning was done on Toshiba Aquillion 16 CT Scanner. Computed tomography evaluation criteria were as follows:

1) Detection of calculus within the urinary tract and its description according To size, number, and location;

2) Assessment of the collecting system and ureteral dilatation (hydronephrosis, hydroureteronephrosis, or both);

3) Asymmetric inflammatory change of the perinephric or periureteral fat (stranding);

4) Presence of nephromegaly.

The locations of urinary calculi were classified as

1) Renal,

2) Upper ureter (extends from the renal pelvis to the upper border of the sacrum)

3) Middle ureter (comprises the segment from the upper to the lower border of the sacrum.)

4) Lower (distal or pelvic) ureter - extends from the lower border of the sacrum to the bladder

The size of each stone (in millimeters) as the greatest dimension was measured within the axial plane of the CT section. We defined ureteral dilatation as present when the ureter was asymmetrically dilated compared with the normal side

A subject was considered was considered positive when a hyperdense ureteric calculus was noted on CT scan and negative when no ureteric calculus was seen

CT scan results were considered the gold standard with which Doppler sonography findings were compared.

After analysing the data, sensitivity, specificity, negative and positive predictive values (NPV and PPV) and accuracy of Doppler US for obstructive uropathy was calculated by corresponding with CT KUB examination using 2/2 table.

True Positive was defined as obstructive uropathy diagnosed on Doppler US and also found on CT KUB.

True Negative was defined as obstructive uropathy not diagnosed on Doppler US and also not found on CT KUB.

False Positive was defined as Obstructive uropathy diagnosed on doppler US, but not found on CT KUB

False Negative was defined as obstructive uropathy not diagnosed on Doppler US, but found on CT KUB.

Sensitivity = True Positive/True Positive + False Negative x 100;

Specificity = True Negative/False Positive + True Negative x 100.

1) PPV (positive predictive value)

=True Positive / True Positive + False Positive x 100,

2) NPV (negative predictive value)

=True Negative / False Negative + True Negative x 100.

3) Diagnostic Accuracy was calculated by the formula:

$$\frac{\text{True Positive + True Negative}}{\text{True Positive + False Positive + False Negative + True Negative}} \times 100$$

OBSERVATIONS AND RESULTS

The demographic and clinical features of 200 patients investigated in this study are as follows

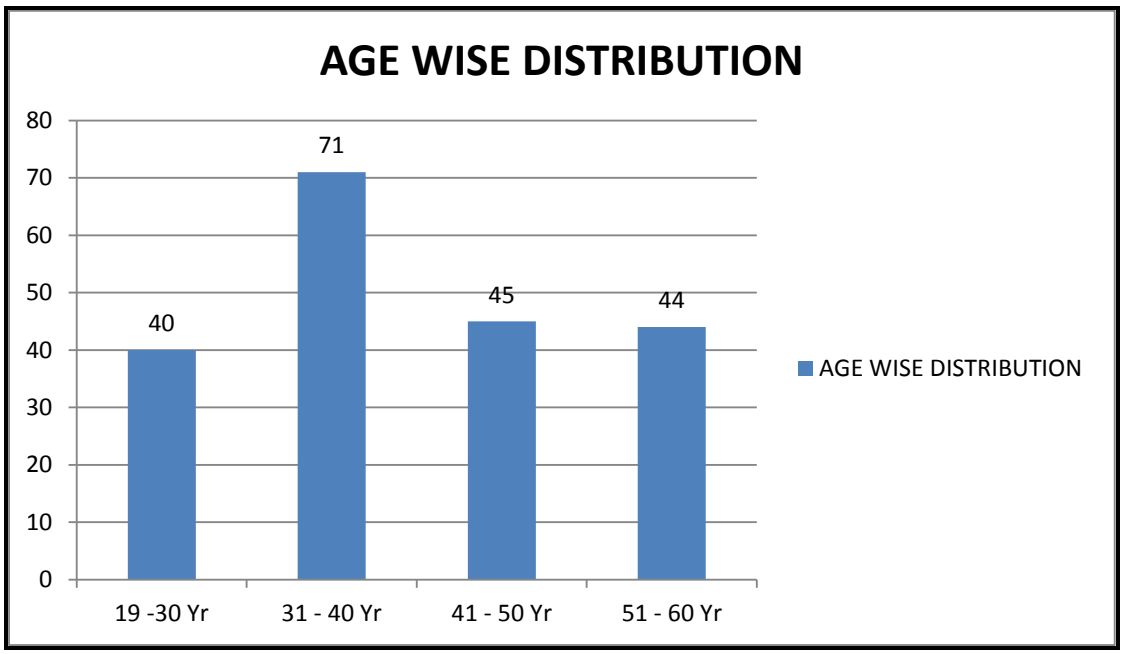
TABLE 1 - AGE WISE DISTRIBUTION

AGE GROUP	NO OF PATIENTS	PERCENTAGE
20-30	40	20
31-40	71	35.5
41-50	45	22.5
51-60	44	22
TOTAL	**200**	**100**

Mean age of the patient in our study is 39.52 and standard deviation is 10.515

Minimum age of our study is 20 year and maximum age is 60 year. Median age is 38 years.

TABLE 1- AGE WISE DISTRIBUTION OF THE PATIENTS



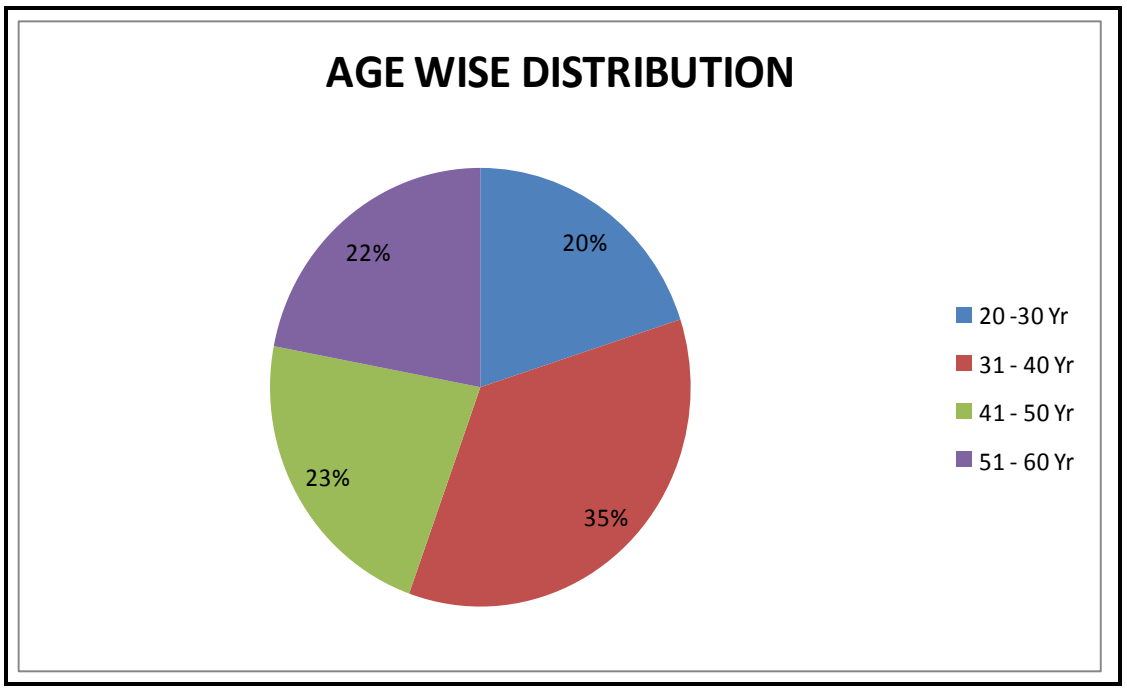
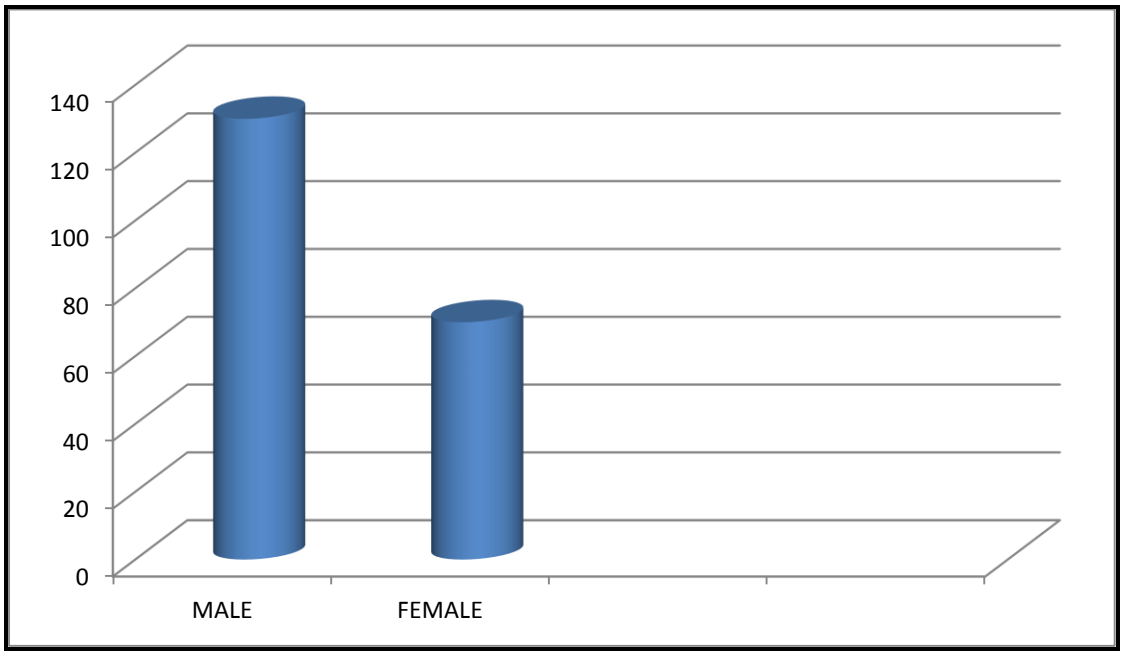


TABLE -2 SEX DISTRIBUTION

SEX	NO OF PATI ENTS	PERCENTAGE
MALE	130	65
FEMALE	70	35
TOTAL	**200**	**100**

In our study out of 200 patients 130 patients were male and 70 patients were female. the male female ratio was 65:35

TABLE 2 SEX WISE DISTRIBUTION



CLINICAL FEATURES

TABLE 3: SIDE OF FLANK PAIN

SIDE OF FLANK PAIN	NO OF PATIENTS	PERCENTAGE
RIGHT	102	51
LEFT	98	49
TOTAL	**200**	**100**

TABLE 5 SIDE OF FLANK PAIN

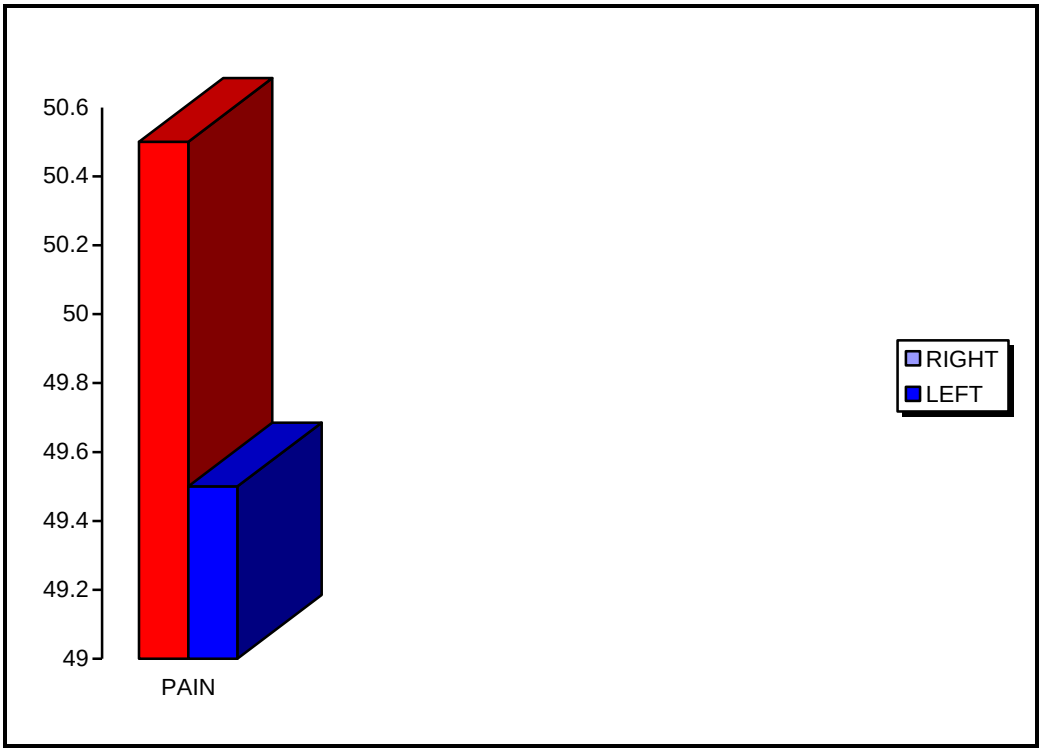


TABLE- 4 CLINICAL FEATURES

Symptoms	No of patients	Percentage
Dysuria	129	64.5%
Hematuria	57	28.5%
Nausea / Vomiting	122	61 .0%

TABLE 3- FREQUEACY OF SYMOTOMS

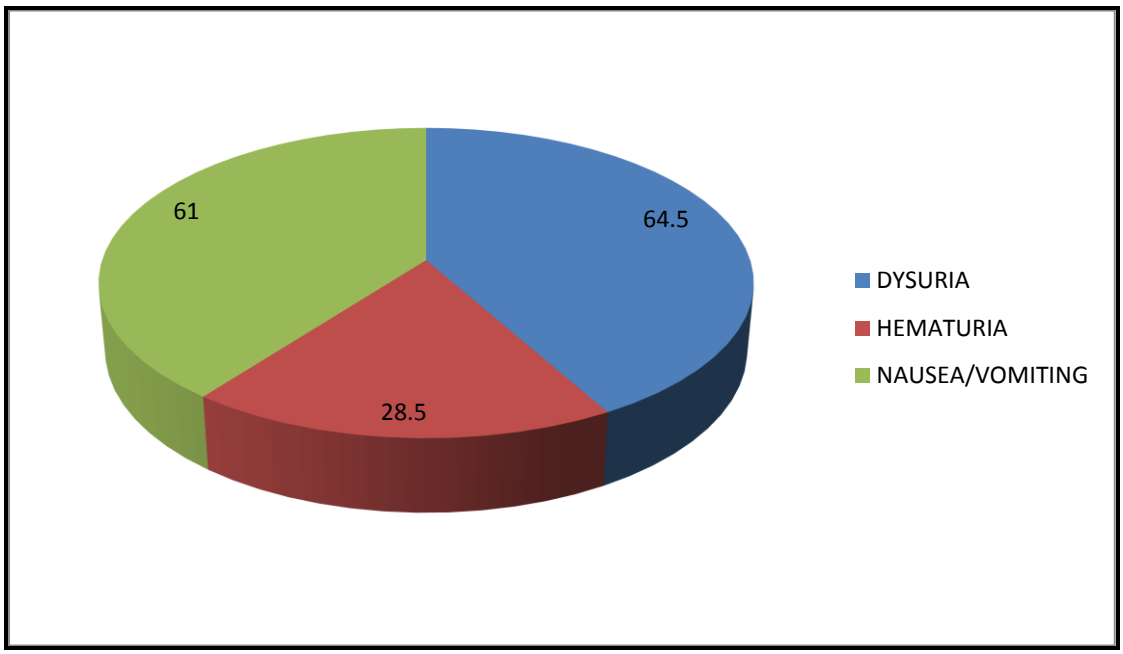


TABLE- 5 LABORATORY VALUES

Lab. Values	No. Of Patients	Percentage
Leukocytosis	151	76
Microhematuria	124	62
Crystalluia	119	59.5
Bacteriuria	46	23

TABLE 4 LAB VALUES

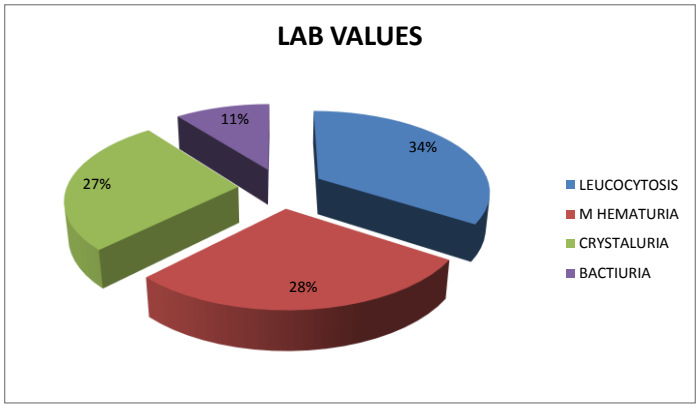


TABLE 6 X RAY KUB FINDING

X – Ray KUB	No. of Patients	Percentage
ROS Present	114	57%
ROS Absent	86	43%

TABLE 7 USG GRADINGS OF HYDROURTERONEPHROSIS

HUN – Grade	No of Patients	Percentage
0	73	36.5%
1	32	16.0%
2	49	24.5 %
3	46	23.0%

TABLE6 ULTRA SOUND GRADING

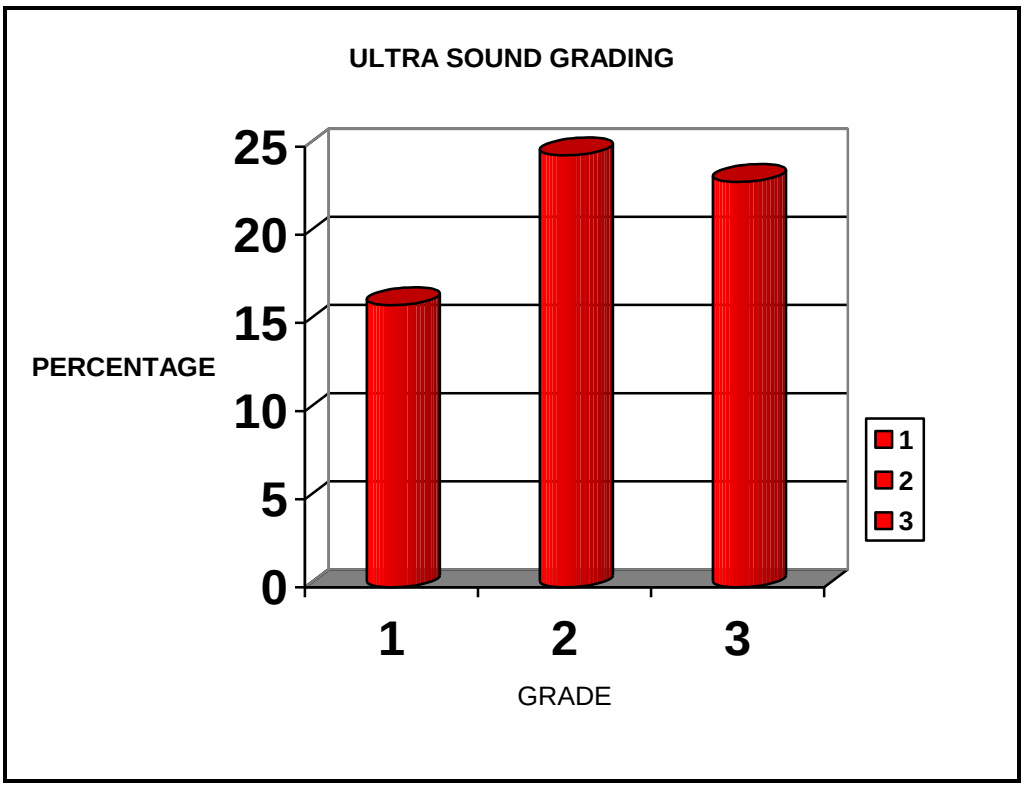


TABLE -8 COLOUR DOPPLER FINDINGS OF RESISTIVE INDEX

RI Values	No. Of Patients	Percentage
> 0.70	104	50.5%
< 0.70	96	49.5 %
Total	**200**	**100%**

MEAN RI OF WAS FOUND TO BE 0.7004 STANDARD DEVIATION IS 0.0667

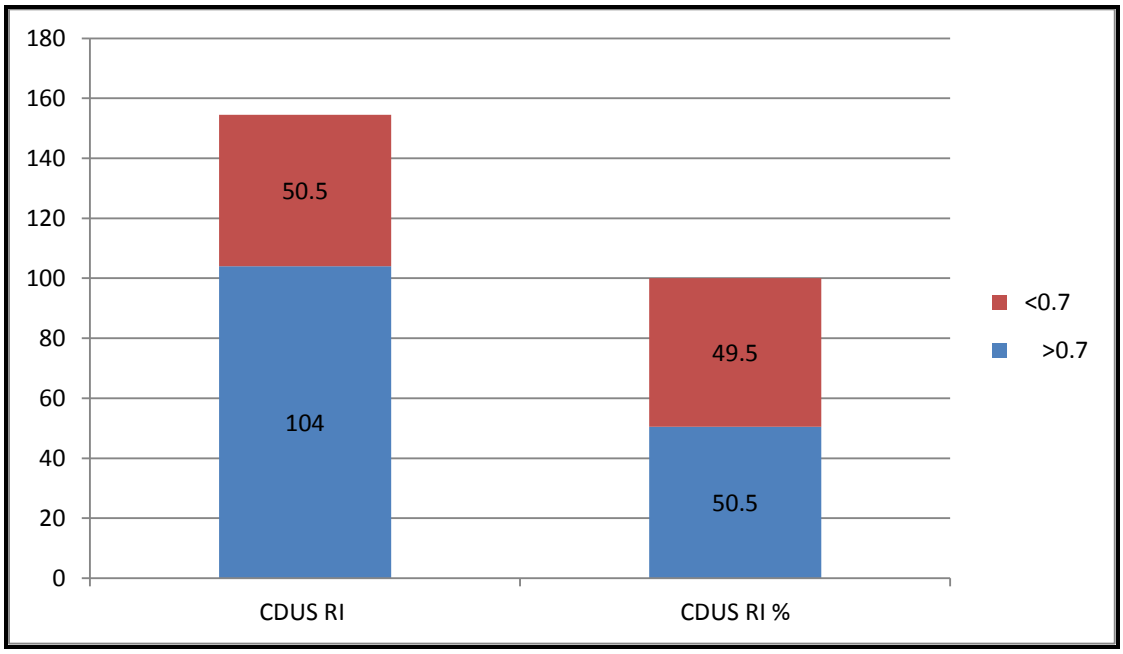


TABLE - 9 COLOUR DOPPLER FINDINGS OF DELTA RESISTIVE INDEX

Delta RI Values	No.of Patients	Percentage
0.01 to 0.04	81	40.5%
0.05 to 1.0	119	59.5%
Total	**200**	**100 %**

Mean delta RI was 0.0927 and standard deviation is 0.0500

Mean RI compared with mean DRI shows statiscally significant ($p<0.001$)

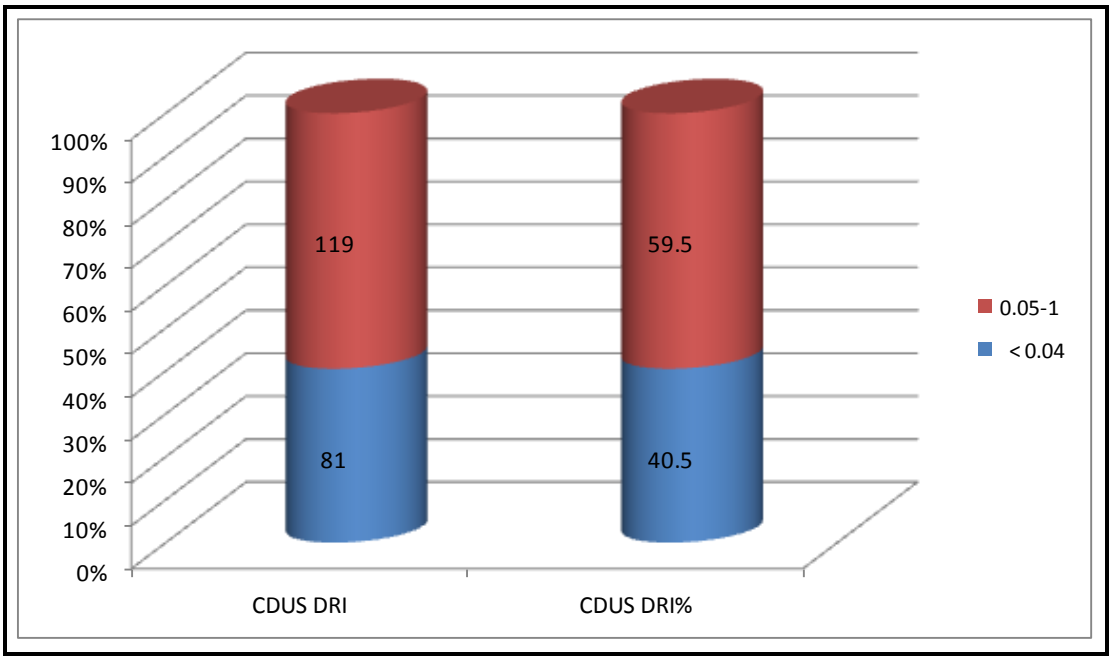


TABLE -10 CT KUB – FINDINGS OF LOCATION OF STONE

Stone location	No of Patients	Percentage
Renal Pelvis	11	8.66
Upper Ureter	31	24.40
Mid ureter	23	18.11
Lower ureter	62	48.81
Total	**127**	**100**

TABLE 7 -CT SCAN DIFFERENT SITE OF OBSTRUCTION

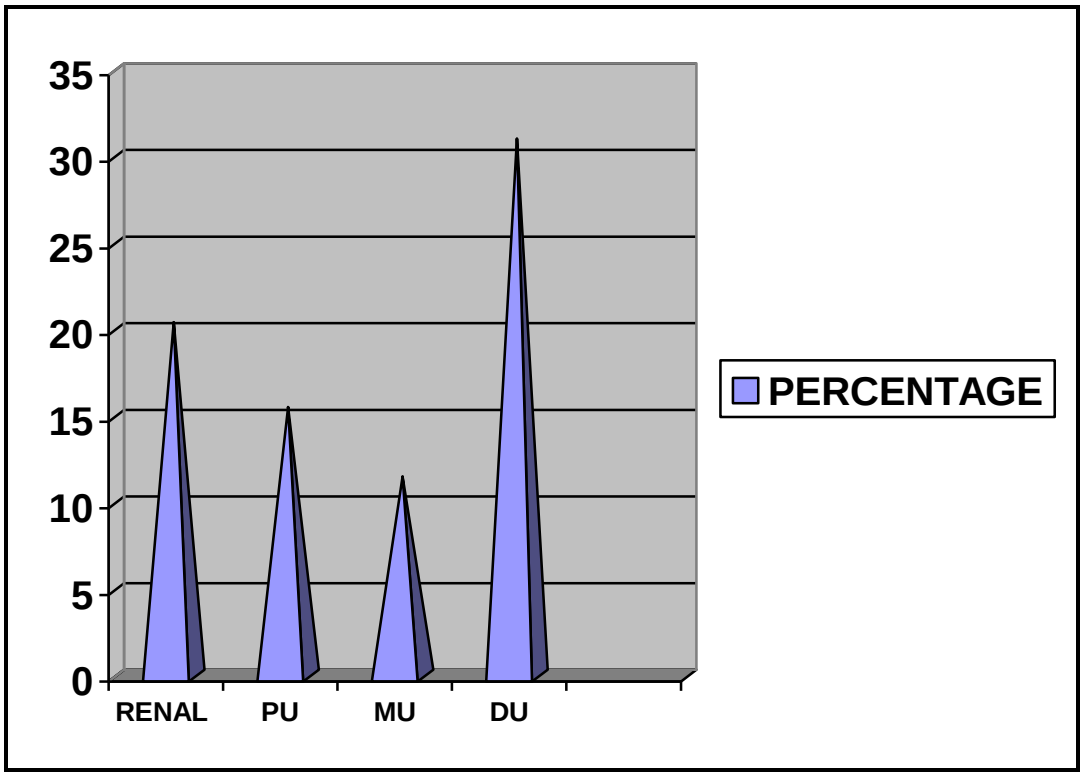


TABLE –11 CT FINDINGS - STONE SIZE

Stone Size	No of Patients	Percentage
Less than 5mm	36	28.34
More than 5 mm	91	71.65
Total	**127**	**100**

TABLE -12 CORRELATION OF CT AND CDUS RI FINDING

CDUS RI	CALCULUS PRESENT ON CT	CALCULUS ABSENT ON CT	TOTAL
>0.7	95(91.34%)TP	9(8.66%)FP	104(52%)
< 0.7	32(33.33%)FN	64(66.67%)TN	96(48%)
TOTAL	127(63.5%)	73(36.5%)	200(100%)

Ureteric calculus was noted on CT scan in 127 (63.5%) patients, and it was not present in 73patients (36.5%).

RI was found to be >0.70 in 104 (52 %) patients. Calculus was seen on CT scan in 95(91.34 %) of these 104 patients, so these patients were True Positive and constituted 47.5 %of the total sample.

In the remaining of 9 (8.66%) of these 104 patients, calculus was not seen on CT scan. These False Positive patients constituted 4.5% of the total sample.

RI was found to be < 0.70 in 96 (48 %) of the 200 patients. Ureteric calculus was seen on CT scan in 32 (33.33%) of these patients, who were False Negative and constituted 16% of the total sample.

In 64 (67.7%) of these 96patients, ureteric calculus was not seen on CT scan, so they were True Negative and constituted 32 % of the total sample.

Other causes of loin pain seen on CT scan of 200 patients were appendicitis in 26 (13 %) patients, diverticulitis in 17 (8.5%), Spondylolysis in 13 (6.5 %), while no cause of pain was seen in 17 (8.5 %).

By taking RI value of > 0.70 as a discriminatory level for obstruction, the overall sensitivity of RI was 74.80 % and specificity was 87.83 %. The PPV of RI was 91.34% and NPV was 66.66%. The diagnostic accuracy of the test was 79.5%.

TABLE13 CORRELATION OF CDUS DELTA RI WITH CT SCAN FINDINGS

Delta RI	CALCULUS PRESENT ON CT	CALCULUS ABSENT ON CT	TOTAL
>0.06	97 (93.26) TP	7 (6.74) FP	104(52%)
<0.06	30 (31.25) FN	66 (68.75) TN	96(48%)
TOTAL	**127(63.5%)**	**73(36.5%)**	**200**

Delta RI was found to be >0.06 in 104 (52 %) patients. Calculus was seen on CT scan in 97(93.26 %) of these 104 patients, so these patients were True Positive and constituted 48.5 %of the total sample.

In the remaining of 7 (6.74%) of these 104 patients, calculus was not seen on CT scan. These False Positive patients constituted 3.5% of the total sample.

Delta RI was found to be < 0.06 in 96 (48 %) of the 200 patients. The ureteric calculus was seen on CT scan in 30 (31.25%) of these patients, who were False Negative and constituted 15% of the total sample.

In 66 (68.75%) of these 96patients, ureteric calculus was not seen on CT scan, so they were True Negative and constituted 33 % of the total sample.

By taking Delta RI value of > 0.06 as a discriminatory level for obstruction, the overall sensitivity of DRI was 76.37 % and specificity was 90.41 %. The PPV of RI was 93.26 % and NPV was 68.75%. The diagnostic accuracy of the test was 81.5%.

TABLE 14 CDUS RI COMPARED WITH CDUS DELTA RI

	CDUS RI	**CDUSDRI**
SENSITIVITY	74.80%	76.37%
SPECIFICITY	87.83%	90.41%
PPV	91.34%	90.41%
NPV	66.66%	93.26%
DIAGNOSTIC ACCURACY	79.50%	81.5%

DISCUSSION

In our study patients with flank pain presented to the causality KMCH and GRH Chennai who fulfil the inclusion and exclusion criteria stated in the methodology were selected after obtaining informed consent. 200 patients were enrolled for this study and routine urological workup done.

Patients presented with unilateral flank pain were initially evaluated with bilateral colour Doppler ultrasound. Renal resistivity index calculated for obstructed kidney and unobstructed contrlateral kidney .Renal RI of more than 0.7 and delta RI of more than 0.06 were taken as a diagnostic obstructive uropathy.

All patients subsequently underwent unenhanced CT KUB within 12 hours of CDUS Examination.CT KUB results were taken as gold standard with which CDUS findings compared. All the reports have been documented in the porfoma and the result were analyzed.

Among two hundred patients studied 40 patients(20%) belonging to age group between 20 to 30 tears.71 patients (35.5%)belonging to 31 to 40 years.45 patients (22.55%) belongs to 41 to 50 years .44 patients(22%) belong to age group 51 to 60

years. Mean age of our study was 39.52 year and standard deviation is 10.515. Median was 38 years.

Among two hundred patients studied 130 were male (65%) and 70 were female (35%) in our study.102 patients (51%) presented with right flank pain and 98 patients (49%) were presented with left flank pain

In our study dysuria is the most common symptom which account for 64.5% followed by nausea / vomiting 61% and hematuria 28.5 %

Lecocytosis was the most common lab finding in 76% followed by microscopic hematuria (62%) crystaluria (59.5%) and bacteuria (23%)

In our study, 127 patients were diagnosed as stone disease. X ray KUB detected radio opaque shadow in 114 (89.76%) patients.13 patients (10.23%) had radiolucent stone which was later detected by CT KUB.

Ultra sound imaging showed mild hydronephrosis in 16% patients, .moderate and severe obstruction were observed in 24.5%and 23% of patients respectively.

CDUS revealed Renal resisitive index of more than 0.70 in 104 (50.5) patients and RI of less than 0.70 in 96 (49.5%) patients

Delta Resistive index of more than 0.06 was observed in 104 (52%) patients and DRI of less than 0.06 was observed in 96(28%) patients.

Plain CT – KUB identified renal pelvic stones in 11 patients (8.66%), Upper ureteric stone in 31patients (24.40%), mid ureteric stones in 23 patients (18.11%) and Lower ureteric stones in 62 patients (48.81%)

36 patients (28.3%) had less than 5mm stones whereas 91 patients (76.65%) presented with more than 5mm stones in CT KUB evaluation

In our study 127 patients were detected to have features of obstruction with CT KUB. Among them 32 patients showed renal resistive index of less than 0.70. This False Negativity was due to the early presentation of the patients to the hospital just after the onset of symptoms and also due to NSAID intake before coming to hospital

In 9 patients (4.5%) of our study sample, RI was found to be >0.70. But, ureteric calculus was not seen on CT scan. This False

positivity of our study may be due to factors that elevate RI like reno vascular resistance, vascular compliance, Plasma rennin, abnormal heart rate, iatrogenic cause like manual compression with Doppler probe.

64 patients of our study had symptoms of obstructive uropathy, but their RI found to be less than 0.70 and no calculus was seen on CT scan. This group of patients were True Negative sample. In these patients, CT scan revealed Non- Urological diseases like appendicitis, diverticulitis,spondylolysis, bowel obstruction / hernia, intra-abdominal fluid collections, tubo-ovarian abscess, aortic aneurysms, pancreatitis.

In our study elevated RI of more than 0.7 was found to be 74.8 % sensitive which is also comparable with the results of Geavlete et al, and specificity 87.83% which is also comparable to Ashraf et al , Platt et al.

Mean RI of our study found to be 0.70 (SD: 0.0667) which is also comparable with results of Amin et al, Sauvian et al, Dee Toledo et al.

Positive predictive value and Negative predictive value of RI were found to be 91.34%, and 66.66% respectively. The Diagnostic accuracy of RI is 79.5%

In our study raised Delta RI of more than 0.06 was found to be 76.37% sensitive and 90.41% specificity. It has positive predictive value of 93.26% and Negative predictive value of 68.75%. The Diagnostic accuracy of delta RI is 81.5%

Mean delta RI of our study found to be 0.09 (SD: 0.05) which is also comparable with results of Kavakli et al, Geavlete et al,Amin and Ghaffar et al,Opdenakker et al

A majority of the patients in our study had taken NSAIDs before the Doppler examination. This also explains the overall low sensitivity of RI in our study..

It is also important to states that the sensitivity and specificity of the RI varies with degree of obstruction. Data in the scientific literature confirm that this marker is more sensitive in the diagnosis of complete rather than partial obstructions[35.36.]

RI is the useful prognostic marker for treatment and follow up of acute urinary tract obstruction. Patients with RI of >0.70 need prompt urinary tract decompression to prevent irreversible

damage. If we repeat the imaging after the decompression of the obstructive system, we can confirm the normalisation of RI .

We were unable to investigate the shortest duration of acute renal obstruction that can cause elevation of RI, since most of our patients presented with renal colic of >6 h duration.

The most common reason for obtaining a normal RI in the presence of significant obstruction is a technical error. This can be corrected by the use of the correct scale (pulse-repetition frequency) to expand the wave form size to fill as much of the available display as possible

A possible limitation of this study was that it did not include other causes of raised RI, like Time-dependence and NSAID-dependence factors . These factors need to be further evaluated in future researches so their effects on RI could be completely understood.

CONCLUSION

1) Renal RI is less sensitive in diagnosing acute ureteric obstruction. Because RI has been shown to be influenced by various factors like patient's age, hydration status, time of presentation, degrees of obstruction , plasma rennin level, pyelo sinus extravasation, NSAID intake, Iatrogenic factors (manual compression of transducer).

2) If delta RI is applied, sensitivity and specificity in diagnosing complete ureteric obstruction will be increased.

3) CDUS should be used in pregnant patients, children and those with a risk of contrast allergy. However, it cannot replace CT as a gold standard diagnostic test.

4) CDUS is also useful for follow-up of recurrent stone patients to rule out new or residual obstruction.

5) Resistivity indices within the normal range did not rule out obstruction. Hence, the renal resistivity indices should not be interpreted in isolation

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PROFORMA

Name: Age: Sex: OP/IP no:

Address:

Symptoms:

Flank pain (R /L)	Dysuria	Hematuria	Nausea / Vomiting

Associated co-morbid illness:

HT	DM	Renal disease	CAD	

Investigations:

leukocytosis	Microscopic hematuria	crystaluria	bacteriuria

X ray - KUB	USG – STONE	USG -HUN	

Color Doppler Ultrasound (CDUS) of the renal RIs with measurements

RI OF OBSTRUCTED KIDNEY	RI NORMAL KIDNEY	DELTA RI

CT FINDINGS

SITE OF STONE	SIZE OF STONE	GRADING

SNO	NAME	AGE	SEX	IPNO	PAIN		DYSURIA	HEMTURIA	Nau/vomiLeuko	LECOCYTO	M HEMAT	crysta	bacteriuriaXrayKUB	ROS /xray	US GRADE	CDUS RI	CDUS DRI	calcu.on CT	CT SITE	stone size
1	SUGANYA	21	F	19134	R		P	p	p	p	A	A	A	P	2	0.75	0.07	P	DU	9mm
2	MADHAVAN	22	M	19270	R		p	A	A	A	A	A	A	P	1	0.68	0.04	P	renal	6
3	LOGANATHAN	35	M	18634	R		P	A	P	P	P	A	A	P	1	0.67	0.05	p	PU	5
4	SALIM	26	M	19149	L		P	A	P	P	P	P	A	P	2	0.74	0.08	P	DU	6
5	SURESH	33	F	19220	L		P	P	P	P	P	A	A	P	2	0.73	0.06	P	DU	5
6	RAJENDIRAN	42	M	2040	L		A	A	P	P	A	A	A	A	0	0.59	0.03	A	nil	nil
7	SATHIYA	24	M	49493	L		P	P	P	P	P	P	P	P	3	0.77	0.09	P	DU	8
8	ARUNACHALAM	45	M	20744	L		A	A	P	A	A	A	A	A	0	0.57	0.04	A	nil	nil
9	MUTHU	53	M	18594	L		P	A	P	P	A	A	A	A	0	0.6	0.05	A	nil	nil
10	BHEEMRAJ	21	M	17741	R		P	P	P	P	P	P	P	P	3	0.77	0.08	P	DU	9
11	RAJAMANICKAM	55	M	18002	L		A	A	P	P	A	A	A	A	0	0.62	0.04	A	nil	nil
12	KOTHANDERAMAN	54	M	18835	R		P	A	A	P	A	A	A	A	0	0.65	0.02	A	nil	nil
13	SAM	40	M	20671	R		A	A	P	A	A	A	A	A	0	0.7	0.03	A	nil	nil
14	JENIFER	26	F	19878	R		P	A	A	P	P	A	A	A	1	0.69	0.05	P	MU	6
15	ARULMURUGAN	21	M	20747	R		P	A	A	P	P	A	A	P	1	0.71	0.06	P	renal	5
16	ADHIMOOLAM38	38	M	24874	L		P	A	P	P	P	P	A	P	2	0.72	0.07	P	DU	7
17	VALAIYAPATTI	52	M	22127	L		A	A	P	P	A	A	A	A	0	0.66	0.02	A	nil	nil
18	DEEPA	25	F	21700	L		P	A	P	P	P	P	A	P	2	0.74	0.07	P	DU	6.5
19	KRISHNAVENI	45	F	2192	R		P	P	A	A	P	P	A	P	2	0.77	0.08	P	DU	7
20	MURAGAN	60	M	21931	R		A	A	A	A	A	A	A	A	0	0.58	0.01	A	nil	nil
21	SIVAGAMI	55	F	21434	R		P	A	P	P	P	P	P	P	2	0.73	0.07	P	DU	6
22	NAGABOOSHAM	48	F	22706	R		P	A	A	P	P	P	A	P	1	0.71	0.06	P	MU	5.5
23	GOPI	22	M	22805	R		P	A	P	P	P	P	A	P	1	0.69	0.05	P	pelvic	4
24	SHANTHI	40	F	22711	R		P	P	P	P	P	P	P	P	3	0.82	1	P	PU	6
25	MURUGESAN	32	M	24850	R		A	A	P	A	A	A	A	A	0	0.59	0.02	A	nil	nil
26	MARUTHAPANDIYAN	32	M	24618	L		P	A	P	P	P	P	A	P	2	0.74	0.06	P	DU	6.5
27	SARASWATHI	34	F	24855	L		P	P	A	P	A	P	A	P	2	0.78	0.07	P	DU	8
28	VIJAYALAKSHMI	45	F	25110	L		P	P	A	P	P	P	P	P	3	0.76	0.08	P	DU	10
29	SATHISKUMAR	38	M	25580	L		P	P	P	A	P	P	P	P	3	0.81	0.09	P	DU	11
30	PREMA	35	F	3566	R		P	A	A	A	P	P	A	P	1	0.67	0.04	P	Renal	5.5
31	MANJULA	52	F	26833	R		P	P	P	P	P	P	P	P	3	0.78	0.08	P	DU	9.5
32	MOHAN	32	M	26833	L		P	P	A	A	P	P	A	P	3	0.75	0.08	P	DU	10
33	ANANDHAN	28	M	27202	R		A	A	P	A	A	A	A	A	0	0.6	0.01	A	nil	nil
34	VARADHARAJAN	57	M	16543	L		A	A	A	A	A	A	A	A	0	0.71	0.04	A	nil	nil
35	VIMAL	38	M	26972	R		P	P	P	P	P	P	A	P	2	0.72	0.06	P	DU	7
36	VIKRAMAN	51	M	27353	L		A	A	P	P	A	A	A	A	0	0.61	0.02	A	nil	nil
37	SOWMYA	19	F	27794	L		P	P	P	P	P	P	P	P	3	0.76	0.08	P	DU	8.5
38	ELUMALAI	58	M	26045	L		P	A	P	P	P	P	A	P	2	0.74	0.07	P	DU	6.5
39	SHOBIKA	38	F	25978	F		P	P	A	P	P	P	P	P	3	0.75	0.08	P	DU	9
40	DLISATH	35	F	26049	L		P	A	P	P	P	P	A	P	2	0.75	0.07	P	DU	8
41	MANOHAR	32	M	26531	L		P	A	A	P	P	P	A	A	1	0.67	0.03	P	MU	7
42	VELU	37	M	26547	R		P	P	P	P	P	P	P	P	3	0.81	1	P	DU	11
43	MANIKANDAN	25	M	30410	L		P	A	P	P	P	P	A	P	2	0.74	0.07	P	DU	7.5
44	SEKAR	40	M	30153	R		P	P	P	P	P	P	P	P	3	0.77	0.8	P	DU	10
45	SUNDARI	40	F	29399	L		A	A	A	P	A	A	A	A	0	0.63	0.02	A	nil	nil
46	VARADHAN	57	M	27453	L		P	A	P	P	P	P	A	P	1	0.69	0.05	P	DU	6
47	RAVI	43	M	13951	R		P	P	P	P	P	P	P	P	2	0.72	0.07	P	DU	7.5
48	DEVAKI	32	F	18237	R		P	P	P	P	P	P	P	P	3	0.81	0.09	P	PU	5
49	THANGAVEL		40 M	19077	R		A	A	P	P	A	A	A	A	0	0.62	0.04	A	nil	nil
50	NAGARAJAN		44 M	19288	L		P	P	P	P	P	P	P	P	3	0.78	0.08	P	MU	8

51	Ramadevi		*39 F*	19848	R		P	P	P	P	P	P	A	P	2	0.74	0.07	P	PU	5.5
52	Balamurugan		50 M	19841	R		P	P	P	P	P	P	A	P	3	0.77	0.08	P	DU	10.5
53	saroja		50F	19368	R		A	A	A	A	A	A	A	A	0	0.64	0.03	A	nil	nil
54	sivakumar		21M	19585	R		P	A	P	P	P	A	A	A	1	0.69	0.05	P	PU	4
55	Shanmugam		58M	18248	R		P	A	P	P	P	P	A	P	2	0.71	0.07	P	MU	7.5
56	Ramasamy		49M	19863	L		P	P	P	P	P	P	P	P	3	0.79	0.08	P	PU	6
57	Ram Bahadev	dur	29M	20382	R		A	A	A	P	A	A	A	A	0	0.65	0.02	A	nil	nil
58	Viruthambal		40F	20412	R		P	P	A	A	P	P	A	P	3	0.76	0.08	P	DU	10
59	Karuppaiya		59M	19015	R		P	A	P	P	P	P	A	P	2	0.72	0.06	P	DU	8.5
60	Dhamodharan		44M	19001	L		P	A	P	P	P	P	P	P	2	0.73	0.07	P	PU	5.5
61	Shanthakumar		46M	20663	R		A	A	P	A	A	A	A	A	0	0.61	0.02	A	nil	nil
62	Lakshmi		41F	20645	L		P	P	P	P	P	P	A	P	2	0.75	0.07	P	PU	5.5
63	Subramani		38M	20557	L		A	A	A	A	A	A	A	A	0	0.64	0.02	A	nil	nil
64	Ramamoorthy		36M	20487	R		P	A	P	P	P	P	A	P	2	0.74	0.07	P	MU	8
65	Vasantha		48F	17829	L		A	A	A	P	A	A	A	A	0	0.66	0.01	A	nil	nil
66	Arulraj		37M	21205	L		P	P	P	P	P	P	P	P	3	0.79	0.08	P	Pelvic	6.5
67	Bhakkiyam		40F	20483	L		P	P	P	P	P	P	A	P	3	0.8	1	P	DU	12
68	Ellango		30M	20986	R		A	A	A	A	A	A	A	A	0	0.71	0.05	A	nil	nil
69	raman		31M	20643	R		P	A	P	P	P	P	A	A	1	0.67	0.04	A	PU	4.5
70	Mano		40M	20398	L		A	A	A	P	A	A	A	A	0	0.65	0.03	A	nil	nil
71	Kiruba		25F	21443	L		P	A	P	P	P	P	A	P	2	0.75	0.06	P	PU	7
72	sasikumar		32M	21963	L		A	A	A	A	A	A	A	A	0	0.7	0.05	A	nil	nil
73	Kanthan		42M	21986	R		A	A	P	P	A	A	A	A	0	0.65	0.03	A	nil	nil
74	Nagalaksmi		49F	21997	R		A	A	A	P	A	A	A	A	0	0.65	0.02	A	nil	nil
75	Revathi		41F	22234	R		P	P	P	P	P	P	P	P	3	0.76	0.08	P	PU	10
76	Babu		33M	21982	L		P	A	P	P	P	P	P	P	2	0.73	0.07	P	MU	8.5
77	Indira		37F	21986	L		P	P	P	P	P	P	A	P	3	0.75	0.08	P	DU	11
78	Ganesan		45M	22247	R		A	A	P	P	A	A	A	A	0	0.71	0.05	A	nil	nil
79	Siva		32M	23008	L		P	A	P	P	P	P	A	P	1	0.69	0.05	P	MU	5.5
80	Karthikeyan		37M	22492	R		P	P	P	P	P	P	P	P	3	0.79	0.08	P	PU	9.5
81	Rauhul		29M	22877	R		P	A	P	P	P	P	A	P	2	0.74	0.06	P	PU	7.5
82	Arputham		58F	22129	L		A	A	A	P	A	A	A	A	0	0.64	0.03	A	nil	nil
83	Jeya		40F	23186	R		P	P	P	P	P	P	P	P	3	0.82	1	P	PU	10.5
84	Kasi		29M	23511	L		P	A	A	P	P	P	A	P	1	0.68	0.04	P	MU	5
85	vetrivel		24M	23511	R		P	P	P	P	P	P	P	P	3	0.77	0.08	P	DU	8.5
86	Padmavathy		58F	23786	R		P	A	P	P	P	P	A	A	2	0.73	0.06	P	PU	7
87	Bhuveneswari		52F	23561	R		P	P	P	P	P	A	A	P	2	0.72	0.06	P	PU	6.5
88	Jayanthi		30F	23788	L		P	A	P	P	P	P	A	P	1	0.67	0.04	P	DU	5mm
89	Manikam		32M	23025	L		P	P	P	P	P	P	A	P	2	0.78	0.07	P	MU	7
90	NAGARAJAN		40M	25345	R		P	A	P	P	P	P	P	P	2	0.76	0.06	P	DU	7.5
91	Raghu		50M	25033	R		A	A	P	P	A	A	A	A	0	0.66	0.01	A	nil	nil
92	Muthu		49M	26628	L		P	A	P	P	P	P	A	P	1	0.68	0.04	P	DU	6
93	Ambika		30F	26619	L		P	A	P	P	P	P	A	P	2	0.79	0.07	P	PU	8
94	Franscis		50M	26139	L		A	A	A	P	A	A	A	A	0	0.61	0.01	A	nil	nil
95	Latha devi		39F	27417	L		P	A	P	P	P	P	A	P	2	0.72	0.07	P	DU	8
96	Chinniah		49M	26600	R		P	A	A	P	P	P	A	A	1	0.69	0.04	P	MU	5
97	Yasodha		29F	25305	L		P	P	P	P	P	P	P	P	3	0.81	0.09	P	PU	10
98	kuppan		27M	26905	R		P	A	A	P	P	P	A	P	1	0.67	0.04	P	Renal	6.5
99	Abdul Razak		45M	25046	L		P	A	P	P	P	P	A	P	2	0.74	0.07	P	DU	8.5
100	selvi		37F	27422	R		A	A	A	A	A	A	A	A	0	0.65	0.03	A	nil	nil
101	Michael		29M	27465	R		P	A	A	P	P	P	A	P	1	0.69	0.05	P	DU	5.5

102	Lukas		45M	27041	R		A	A	A	A	A	A	A	A	0	0.62	0.02	A	nil	nil
103	sabapathy		55M	27719	R		P	A	P	P	P	P	A	P	2	0.77	0.08	P	PU	7.5
104	Parasuraman		49M	26890	L		A	A	P	A	A	A	A	A	0	0.63	0.01	A	nil	nil
105	Periyasamy		37M	27725	L		A	A	A	P	A	A	A	A	0	0.65	0.04	A	nil	nil
106	Vanitha		26F	28324	L		A	A	A	A	A	A	A	A	0	0.71	0.05	A	nil	nil
107	Chandra		29F	28293	L		P	A	P	P	P	P	A	P	1	0.67	0.04	P	MU	6
108	Baskaran		34M	29960	L		P	P	P	P	P	P	P	P	3	0.78	0.08	P	DU	10.5
109	lokesh		20M	29957	R		P	A	A	P	P	P	A	A	1	0.67	0.04	P	Renal	4.5
110	Radha		52F	29974	L		A	A	P	A	A	A	A	A	0	0.63	0.02	A	nil	nil
111	Nagamuthu		34M	29974	L		P	A	P	P	P	P	A	P	2	0.72	0.06	P	DU	8.5
112	Karnan		22M	30752	L		P	A	A	P	P	P	A	P	1	0.69	0.05	P	PU	5
113	Srinivasan		33M	29986	L		P	P	P	P	P	P	P	P	3	0.76	0.08	P	MU	10
114	Mohana		33F	31047	L		A	A	P	A	A	A	A	A	0	0.66	0.04	A	nil	nil
115	shabeer		29M	31653	L		P	P	P	P	P	P	P	P	3	0.81	1	P	PU	9.5
116	Rani		51F	31033	R		P	A	P	P	P	P	A	P	2	0.73	0.06	P	MU	7.5
117	Jamesh		37M	33331	L		A	A	A	P	A	A	A	A	0	0.57	0.01	A	nil	nil
118	Saritha		24F	33343	L		A	A	P	A	A	A	A	A	0	0.71	0.05	A	nil	nil
119	Jagan		22M	33633	L		P	A	A	P	P	P	A	A	1	0.68	0.04	P	MU	5
120	Prabhakaran		30M	33896	M		A	A	A	A	A	A	A	A	0	0.65	0.01	A	nil	nil
121	Kesavan		32M	34483	L		P	P	P	P	P	P	P	P	3	0.78	0.08	P	PU	10
122	Sriramalu		53M	34188	R		A	A	A	P	A	A	A	A	0	0.61	0.02	A	nil	nil
123	Lalitha		51F	34187	L		P	A	P	P	P	P	A	P	2	0.74	0.06	P	DU	7.5
124	Pandiyan		35M	35069	R		A	A	P	A	A	A	A	A	0	0.63	0.03	A	nil	nil
125	Kumar		32M	35326	L		P	A	A	P	P	P	A	P	1	0.69	0.05	P	Renal	5
126	Selvaraj		41M	35465	L		P	P	P	P	P	P	P	P	3	0.77	0.08	P	MU	9.5
127	Ayyappan		45M	36301	L		A	A	A	P	A	A	A	A	0	0.59	0.01	A	nil	nil
128	Devathirubai		55F	35992	L		A	A	P	P	A	A	A	A	0	0.63	0.03	A	nil	nil
129	Venda		36F	36866	L		P	A	P	P	P	P	A	P	2	0.72	0.07	P	PU	7.5
130	Balaraman		43M	37748	R		P	P	P	P	P	P	P	P	3	0.79	0.09	P	MU	8.5
131	Vijayan		38M	38018	R		A	A	A	A	A	A	A	A	0	0.63	0.04	A	nil	nil
132	Rajammal		48F	37737	L		P	P	P	P	P	P	P	P	3	0.78	0.09	P	DU	11
133	Uma maheswari		41F	37747	L		A	A	A	A	A	A	A	A	0	0.6	0.02	A	nil	nil
134	Balachander		34M	39608	R		P	A	P	P	P	P	A	P	2	0.73	0.06	P	DU	8
135	Lakshmipriya		28F	40310	R		P	A	A	P	P	P	A	A	1	0.69	0.05	P	DU	4.5
136	Harish		55M	35826	L		A	A	A	A	A	A	A	A	0	0.63	0.04	A	nil	nil
137	Mohd.Basha		53M	40900	L		P	A	P	P	P	P	A	P	2	0.74	0.07	P	PU	7.5
138	Vasudevan		59M	41646	M		A	A	A	A	A	A	A	A	0	0.65	0.04	P	nil	nil
139	Sampath		34M	41664	R		P	P	P	P	P	P	P	P	3	0.83	1	P	PU	10
140	Ayesha		51F	41677	R		A	A	A	P	A	A	A	A	0	0.64	0.03	A	nil	nil
141	Chitra		43F	40907	L		P	P	P	P	P	P	P	P	3	0.78	0.09	P	DU	9.5
142	Gopal		60M	40882	L		A	A	A	A	A	A	A	A	0	0.58	0.01	A	nil	nil
143	Vasudevan		60M	41646	R		A	A	A	P	A	A	A	A	0	0.58	0.02	A	nil	nil
144	Sangeetha		27F	40876	R		P	A	P	P	P	P	A	P	2	0.75	0.07	P	DU	7
145	Arumugam		35M	40916	R		A	A	A	A	A	A	A	A	0	0.6	0.03	A	nil	nil
146	Kannan		22M	40735	R		P	A	A	P	P	P	A	A	1	0.67	0.04	P	PU	5.5
147	Munusamy		59M	40113	R		P	P	P	P	P	P	P	P	3	0.81	1	P	PU	10.5
148	Suresh kumar		38M	40319	R		A	A	A	A	A	A	A	A	0	0.66	0.02	A	nil	nil
149	Revathy		29F	40318	L		P	A	P	P	P	P	A	P	2	0.74	0.06	P	PU	8
150	Mathivanan		40M	40322	L		A	A	P	P	A	A	A	A	0	0.64	0.01	A	nil	nil
151	Shanthi		34F	40511	R		P	A	A	P	P	P	A	P	1	0.66	0.05	P	Renal	6
152	Anthoniammal		43F	40563	L		A	A	A	A	A	A	A	A	0	0.65	0.02	A	nil	nil

153	Mohandoss		24M	40558	L		p	A	A	P	P	P	A	P	1	0.67	0.05	P	DU	5.5
154	Arokiyam		35M	40675	R		A	A	A	P	A	A	A	A	0	0.71	0.05	A	nil	nil
155	Vennila		41F	41818	R		A	A	P	A	A	A	A	A	0	0.57	0.04	A	nil	nil
156	Rajesh		24M	41733	R		P	P	P	P	P	P	P	P	3	0.79	0.09	P	PU	9.5
157	Arivazhan		30M	41572	R		P	A	A	P	P	P	A	P	1	0.69	0.04	P	PU	6
158	Amsa		41F	41555	R		A	A	A	A	A	A	A	A	0	0.58	0.01	A	nil	nil
159	sivalingam		54M	41897	R		P	A	P	P	P	P	A	A	2	0.78	0.07	P	MU	6.5
160	John Peter		39N	40132	L		A	A	A	A	A	A	A	A	0	0.59	0.02	A	nil	nil
161	krishnan		47M	41333	R		A	A	A	P	A	A	A	A	0	0.7	0.04	A	nil	nil
162	baby		32F	41037	L		P	A	A	P	P	P	A	P	1	0.69	0.05	P	MU	6
163	Parthasarathy		56M	41156	R		P	P	P	P	P	P	P	P	3	0.76	0.08	P	DU	9
164	Ezhilarasan		51M	41699	L		A	A	A	A	A	A	A	A	0	0.66	0.04	A	nil	nil
165	Wasim		49M	41716	L		A	A	A	A	A	A	A	A	0	0.59	0.02	A	nil	nil
166	Kalaiselvi		34F	42734	R		P	P	P	P	P	P	P	P	3	0.82	1	P	DU	12
167	Fahrid		53M	42780	R		A	A	P	A	A	A	A	A	0	0.64	0.02	A	nil	nil
168	Singaravelan		25M	42879	R		A	A	A	P	A	A	A	A	0	0.65	0.03	A	nil	nil
169	Vasuki		43F	40495	L		P	A	P	P	P	P	A	P	2	0.73	0.06	P	DU	8
170	Sridhar		33M	40843	R		P	A	A	P	P	P	A	A	1	0.68	0.05	P	renal	6.5
171	Janaki		29F	40987	R		P	P	P	P	P	P	A	P	2	0.73	0.06	P	DU	8.5
172	Hakkim		48M	41003	L		A	A	A	A	A	A	A	A	0	0.65	0.01	A	nil	nil
173	Ranjith		37M	41165	L		A	A	A	P	A	A	A	A	0	0.64	0.01	A	nil	nil
174	Anitha		26F	40345	R		P	P	P	P	P	P	P	P	3	0.76	0.08	P	DU	9
175	Tamilselvan		46M	41465	R		P	P	P	P	P	P	P	P	3	0.79	0.09	P	DU	9.5
176	Leelavathi		53F	41579	L		P	A	A	P	P	P	A	P	1	0.67	0.04	P	MU	5.5
177	Jeeva		56M	42534	R		A	A	A	A	A	A	A	A	0	0.57	0.02	A	nil	nil
178	Parveen		36F	42980	L		P	A	P	P	P	P	A	P	2	0.75	0.07	P	DU	7.5
179	Maheswaran		41M	41634	R		A	A	A	A	A	A	A	A	0	0.63	0.03	A	nil	nil
180	Sulthan		38M	41671	R		P	P	P	P	P	P	P	P	3	0.76	0.08	P	DU	10
181	Harrish		45M	41702	L		A	A	A	A	A	A	A	A	0	0.58	0.01	A	nil	nil
182	Ansari		32M	41900	R		A	A	P	A	A	A	A	A	0	0.61	0.02	A	nil	nil
183	Selvanayaki		27F	42986	R		P	A	P	P	P	P	A	P	2	0.73	0.06	P	DU	8
184	Christopher		29M	42879	L		P	A	A	P	P	P	A	A	1	0.69	0.05	P	MU	6.5
185	Devan		31M	43003	L		P	P	P	P	P	P	P	P	3	0.81	0.09	P	DU	9.5
186	Arokiyaraj		53M	42987	R		A	A	A	P	A	A	A	A	0	0.62	0.03	A	nil	nil
187	Kotteshwari		36F	43018	L		P	P	P	P	P	P	P	P	3	0.79	0.09	P	DU	8.5
188	Abdul khader		55M	43113	R		P	A	P	P	P	P	A	P	2	0.74	0.07	P	MU	7.5
189	Tyson		38M	43145	L		A	A	A	A	A	A	A	A	0	0.63	0.04	A	nil	nil
190	Partheeban		45M	43179	L		P	P	P	P	P	P	A	P	3	0.77	0.08	P	PU	10
191	Vasanthapriya		35F	43198	R		P	A	P	P	P	P	P	P	2	0.75	0.07	P	DU	7.5
192	Pughayendhi		57M	43187	R		A	A	A	A	A	A	A	A	0	0.64	0.02	A	nil	nil
193	Haritha		41F	43245	L		P	A	P	P	P	P	P	P	2	0.61	0.06	P	DU	7
194	Helen amutha		44F	43364	R		P	P	P	P	P	P	P	P	3	0.74	0.08	P	DU	8.5
195	Udhay		37M	43402	R		P	P	P	P	P	P	A	P	3	0.76	0.09	P	DU	9
196	Kaliraj		55M	43456	L		A	A	A	A	A	A	A	A	0	0.65	0.03	A	nil	nil
197	Noorjahan		51F	43498	R		P	A	P	P	P	P	A	P	2	0.72	0.06	P	renal	6
198	Adhavan		43M	43505	R		A	A	A	A	A	A	A	A	0	0.57	0.02	A	nil	nil
199	sathish		39M	43548	L		P	A	P	P	P	P	A	P	2	0.69	0.06	P	MU	7
200	Benitha		47F	43606	L		P	P	P	P	P	P	P	P	3	0.78	0.08	P	DU	7.5

சுய ஒப்புதல் படிவம் (Informed consent form)

ஆய்வு செய்யப்படும் தலைப்பு **“Renal Resistive Index As A Predictor Of Acute Hydronephrosis In Patients With Renal Colic ”**

பங்கு பெறுபவரின் பெயர்:
பங்கு பெறுபவரின் வயது:
பங்கு பெறுபவரின் எண் :

பங்கு பெறுபவர் இதனை (√) குறிக்கவும்

மேலே குறிப்பட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டுள்ளது என அறிந்து கொண்டேன். ☐

நான் இவ்வாய்வில் தன்னிச்சையாக தான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த சட்டசிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன். ☐

இந்த ஆய்வு சம்பந்தமாகவோ , இதை சார்ந்து மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்கு பெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகக்ளை பார்ப்பதற்க்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். ☐

இந்த ஆய்வின் மூலம் கிடைக்கும் தகவலையோ , முடிவையோ பயன்படுத்திக் கொள்ள மறுக்கமாட்டேன். ☐

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக் கொள்கிறேன். இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன். ☐

பங்கேற்பவரின் கையொப்பம் :_____ இடம் _____ தேதி _____

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்:

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ஆய்வாளரின் பெயர் : _____

Department of Urology - அரசு கீழ்பாக்கம் மருத்துவ கல்லூரி.

ABBREVIATION

RR	Resistive Index
DRI	DELTA Resistive Index
IVU	INNTRAVENOUS UROGRAM
USG	ULTRASONOGRAM
CDUS	COLOUR DOPPLER ULTRASONOGRAM
NECT	NON - ENHANCED COMPUTED TOMOGRAPHY
GFR	GLOMERULAR FILTRATION RATE
BUO	BILATERAL URETERIC OBSTRUCTION
UUO	UNILATERAL URETERIC OBSTRUCTION
HUN	HYDRO URETERO NEPHROSIS
RBF	RENAL BLOOD FLOW
ANP	ATRIAL NATRIURETIC PEPTIDE
MDCT	MULTI DETECTOR CT
DECT	DUAL ENERGY CT
PPV	POSITIVE PREDICTIVE VALUE
NPV	NEGATIVE PREDICTIVE VALUE
ROS	RADIO OPAQUE SHADOW
DA	DIAGNOSTIC ACCURACY

ANNEXURES

1. CERTIFICATE OF APPROVAL FROM ETHICAL COMMITTEE

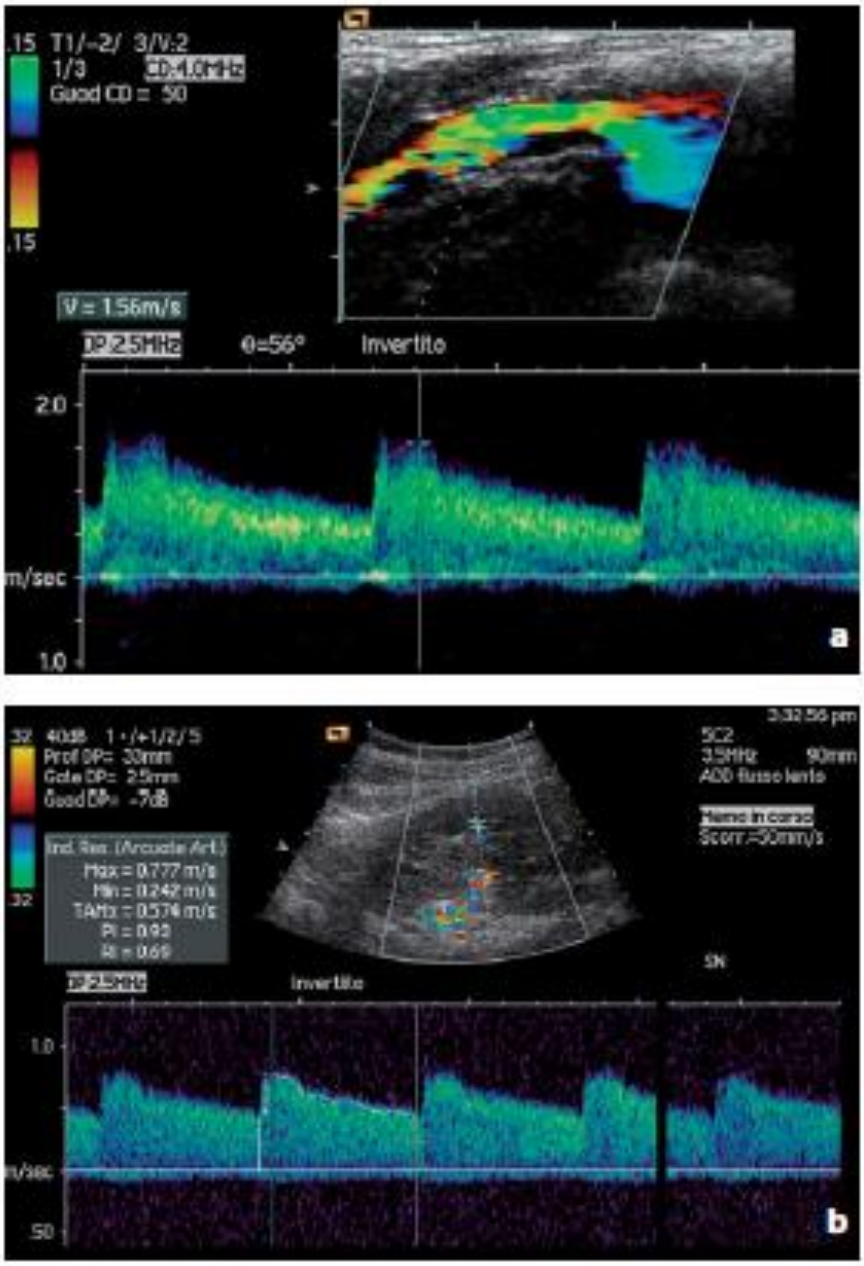
2. PROFORMA

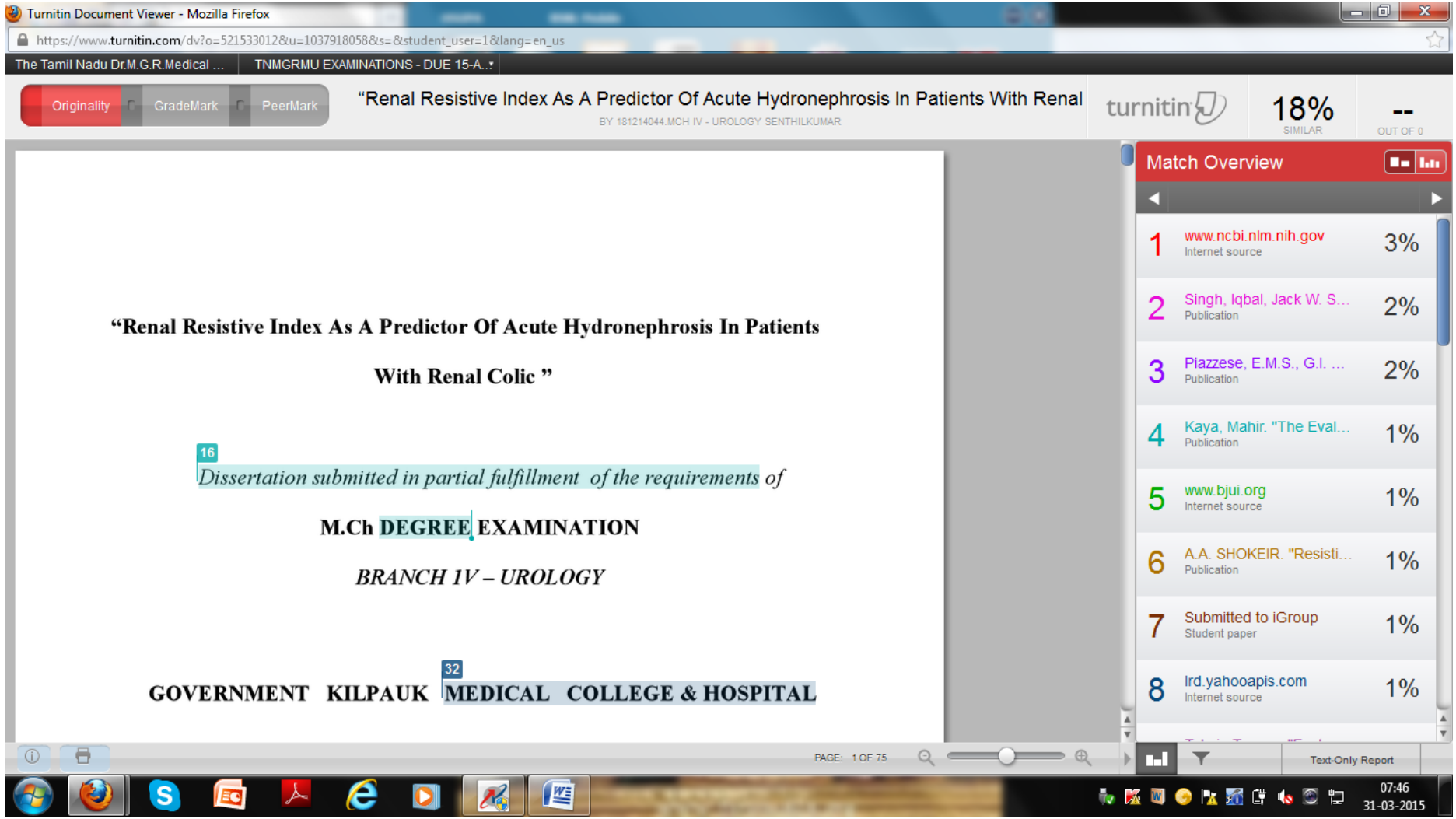
3. MASTER CHART

4. TURNITIN DIGITAL RECEIPT

5. TURNITIN REPORT

COLOUR DOPPLER ULTRASONOGRAM IMAGE

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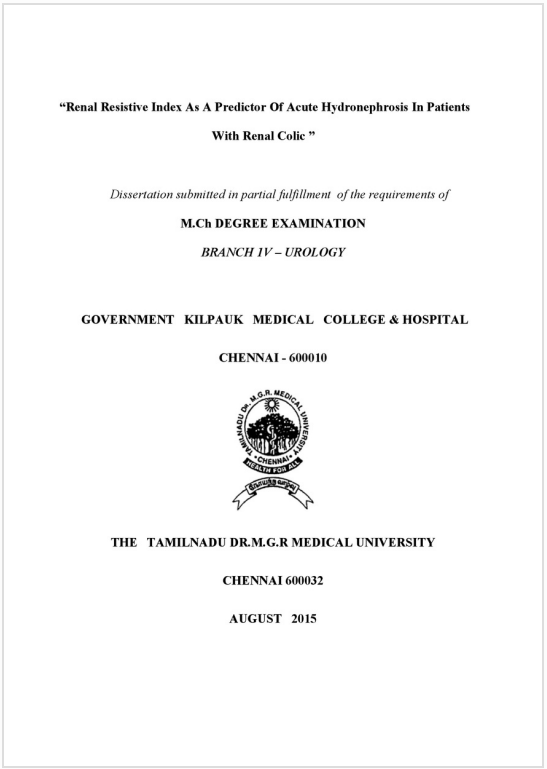

“Renal Resistive Index As A Predictor Of Acute Hydronephrosis In Patients With Renal Colic ”

Dissertation submitted in partial fulfillment of the requirements of

M.Ch DEGREE EXAMINATION

BRANCH IV – UROLOGY

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